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UNIT ORGANIZATION OF TOPICS
AIR AND AVIATION

Submitted by

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(Ed.B., Keene Teachers College, 1940)

In partial fulfillment of requirements for

the degree of Master of Education

1948

First Reader: Dr. Roy O. Billett, Professor of Education

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To you, who search the skies
On wings of word today
To soon the blue you'd touch
With silver wings tomorrow
To all who read, and all who fly
Happy Landing!

Rose Cohen

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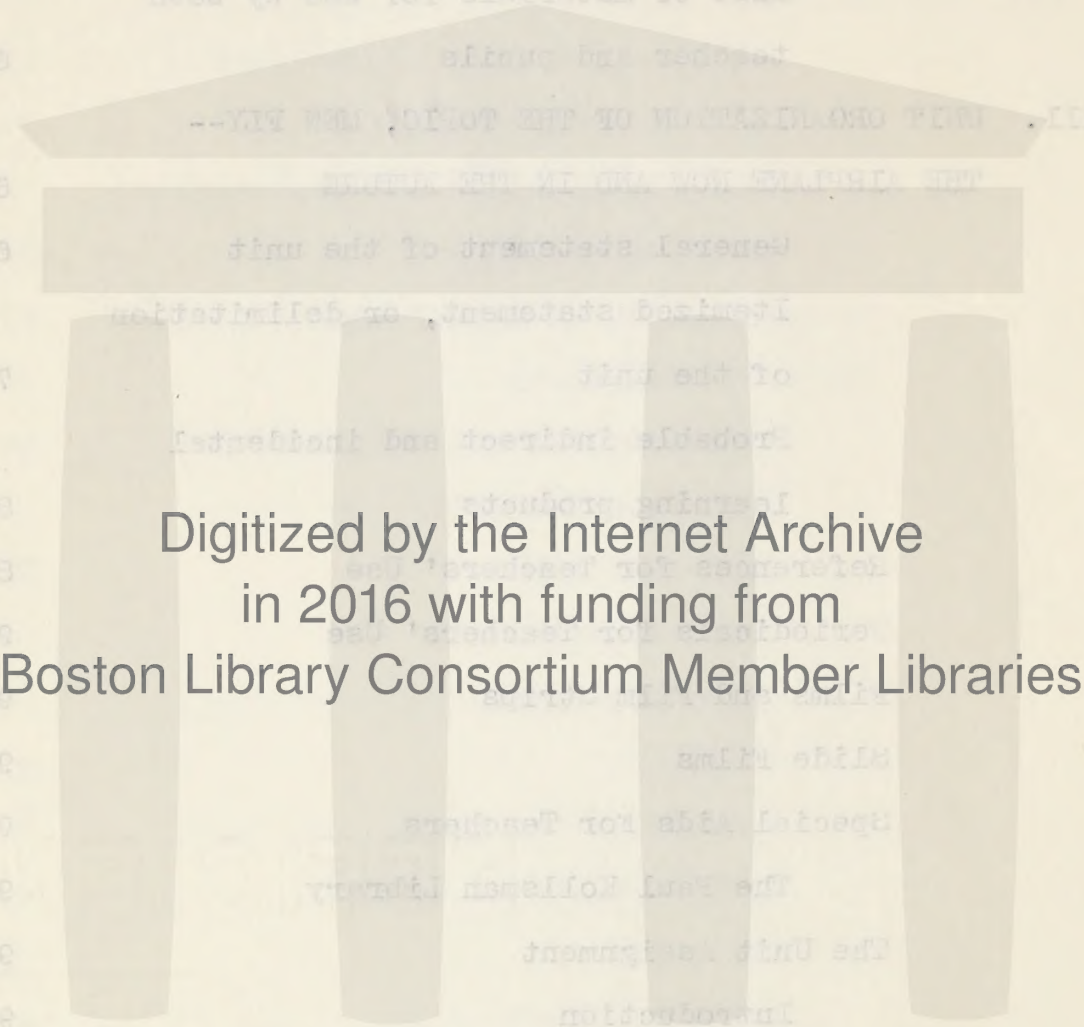

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CHAPTER I

THE SCOPE OF THE STUDY

Statement of the Problem

The problem.-- The problem for this study is the organization of two units of work in general science to be used in a sixth grade. The content of these units can easily be adapted to a seventh or eighth-grade level by simply increasing the vocabulary difficulty.

The purpose of the first unit is to give an introduction to the subject of science with special emphasis on air and how it affects the pupil's life. The second unit deals with flying and how man's everyday living is being affected by aviation. These two units afford ample provision for the utilization of the elements[1/] of the scientific method in the solution of problems. The pupils should become increasingly aware of these elements as they advance through the school and they should increase in ability to apply those elements to the problems they encounter in their lives.

Unit method as used in the study defined.-- All teaching is by some kind of unit, and the decision as to which type to use must be made by the teacher. The unit method to be used in the work planned here is defined as

1/ Victor H. Noll(Chairman), William A. Brownell, Otis W. Caldwell, Gerald S. Craig, Francis D. Curtis, and Ellsworth S. Obourn, Science Education in American Schools, The Forty-Sixth Yearbook of the National Society for the Study of Education, Part I, University of Chicago Press, Chicago, 1947, p. 105.

"a systematic way of taking into consideration and applying with due emphasis every basic educational principle which should function in every good teaching-learning cycle".[1]

Reasons for selecting this method.-- The writer's reasons for selecting the method to be used are as follows:

1. The teacher can adjust the unit to the individual pupil's present level of educative growth. Each of the subject-matter fields is elementary enough to extend down to the nursery school,[2] and complex enough to include the farthest upward and outward reaches explored by professional workers, by university workers at the research level, and by all other creative workers. Thus, the method provides for individual differences and is a method of educating a heterogeneous group.

2. It is a systematic way of planning[3] the pupil's in-school and, to some extent, his out-of-school environment, plus guidance and direction of the pupil's growth within that environment, to the end that the best interests of the individual and of society may be served.

3. It contributes to an effective use of discussions, readings, reports, demonstrations, visual and auditory aids, library work, and projects.

4. It can be made the basis of a gradual process of

1/ From a course entitled "The Unit Method in the Secondary School" given at Boston University School of Education by Prof. Roy O. Billett.

2/ Roy O. Billett, Fundamentals of Secondary School Teaching, Houghton Mifflin Company, Boston, 1940, p. 161.

3/ Op. cit. p. 168.

improvement. Through occasional revisions the topics may be brought to higher and higher levels.

Study of Class for Which Units Were Made

Extent to which class was studied.-- The units which follow are intended for a class of thirty-four pupils of varying abilities in grade six. Before building the units a study was made of the backgrounds, chronological ages, intelligence quotients, abilities, and out-of-school activities of the pupils enrolled in this class.

After this study, it was decided to group the pupils according to ability and interests, whenever individual work was not in order. The class was divided into four groups having six pupils in each group and two groups having five pupils.

The community and the school.-- The community is a town which has a population of approximately 15,000. It is largely a suburban residential section, there being no large industry carried on. The majority of workers commute to nearby Boston for their employ.

Nearly all of the inhabitants are American Born. There is a scattered population of Italians, most of which were born in the United States. This group is of a high-type with many of the children of these families enrolled in the school these units were evolved for.

There are 2,468 pupils enrolled in the schools of the town with 225 of this number attending the six-year elementary school in which these units were used.

Occupational status of parents.-- A thorough survey of the occupational status of the parents of the 34 pupils revealed that the range in types of occupations was wide. The assemblage of pupils had a good home background made up chiefly of parents who were semi-professional to professional. The community is a residential one with the majority of the parents commuting to Boston. Table I gives the percentage of various occupations. Such a study indicates to the teacher the type of information required in the preparation of the ensuing units.

Table 1. Distribution of Parental Occupations as Revealed in Survey.

Occupation of Parent	Number of Pupils
College professor	1
Merchants	3
Company managers	3
Insurance dealers	4
Public accountant	1
Commercial artist	1
Pharmacist	1
Salesmen	5
Bank teller	1
Office workers	3
United States Government workers:	
Post Office Department, clerk	1
Navy Yard foreman	1
Navy Yard engineer	1
United States Navy Captain	1
Railroad foreman	1
Town Department	1
Police sergeant	1
Gardener	1
Manual laborers	3
Total	34

The ages in the group range from 10 years and 4 months to 13 years and 3 months, see Table 2. The range in ages is 2 years 11 months with a median age of 11 years and 9 months.

Meeting the needs of pupils of varying ages had to be dealt with in planning the units since boys and girls of ten years of age have quite different interests from those just entering their teens. The unit assignment can make provision for such varied interests according to physical, social, and mental abilities of the pupils involved.

Table 2. Distribution of 34 pupils According to Chronological Age

Age		Number of Pupils	
Years	Months	Boys	Girls
10	4		1
10	11		1
11	2		1
11	3	2	
11	4	1	3
11	6	2	2
11	8		2
11	9		3
11	10	2	
11	11	1	2
12	0		1
12	1		1
12	2	3	2
12	3		1
12	5	1	
12	11	1	
13	3	1	
	Totals	14	20

Reading ability.-- In reading ability the group rated high. In May, 1947 the group under consideration took the Iowa Silent Reading Tests, Form A, for grades 4 to 9. Results showed that 26 were above grade in average reading

ability. The best reader was an even 3 years in advance of her grade level, while the poorest reader was only 8 months retarded at the time of the test. This comparatively wide range in reading abilities must be taken into consideration in building the units. The distribution of the various reading abilities is given in Table 3.

Table 3. Distribution of Reading Abilities as Obtained on the Iowa Silent Reading Tests, Form A

Reading Age	Number of Pupils	
	Boys	Girls
8.9		1
8.3		2
8.1	1	
7.9		1
7.8		1
7.5		1
7.3	2	
7.2		3
7.1	1	
7.0		1
6.9	1	1
6.8		1
6.7	1	1
6.6	1	2
6.5		1
6.2	2	
6.1		1
5.9	1	
5.8	1	1
5.6	1	
5.5	1	
5.1	1	1
Totals	15	19

A pupil must gain much of his knowlege through reading. It is, therefore, very important[1/] for him to read as

1/ Ruth Strang, Study Type of Reading Exercises, Bureau of Publications Teachers, College, Columbia University, New York, 1935, p. 2.

efficiently as possible. Efficient reading is of prime importance in considering criteria for these units. After the pupils reading ability was determined the writer selected textbooks, supplementary reference books, and adjusted the vocabulary in the pupil activity sheets to the levels represented. In order to further substantiate the reading ability a survey was made of the number of library books read by the group. Table 4 gives the number of library books read from the period September to December.

Table 4. Amount of Outside-of-School Reading Done by Group Under Study

Number of Pupils	Number of Library Books Read
1	22
1	19
4	17
2	15
6	14
1	12
5	11
7	8
5	5
2	3
Totals 34	126

A further study was made of the pupils concerned in respect to their marks received in English. The distribution shown in Table 5 gives the percentages of the marks received by the pupils for both the last and current semesters of school. This study is based on the pupils' reading ability determined previously by standardized testing. The figures in parenthesis represent percentages for the last semester,

while the figures without parenthesis, represent the percentages for the current term.

This study was made to further enhance criterea used in determining the selection of reading and reference material for the units.

Table 5. Percentage Distribution of English Marks Attained by Pupils Grouped According to Reading Ability

Reading Group	Per Cent of Marks Attained by Each Group					
	A	B	C	D	E	Total
1. Pupils above grade in both comprehension and rate	12(8)	28(25)	35(39)	21(20)	4(8)	100
2. Pupils above grade in comprehension but below grade in rate	4(3)	20(18)	45(43)	28(26)	3(10)	100
3. Pupils below grade in comprehension but above grade in rate	0(0)	3(2)	15(12)	44(40)	38(46)	100
4. Pupils below grade in both comprehension and rate	0(0)	4(3)	24(22)	43(41)	29(34)	100

Intelligence quotients.-- On March 4, 1947, all pupils concerned in this study were given the Otis Quick-Scoring Mental Ability Tests, Beta Test: Form B, for Grades 4 - 9. The distribution of intelligence quotients obtained in this test is given in Figure 1.

while the figures without parentheses represent the per-
centages for the current term.

--- Data-study was made to further evaluate criteria used
in determining the selection of reading and reference
material for the units.

Table 5. Percentage distribution of English Form attained
by Pupils Grouped according to Reading Ability

Reading Group	Per Cent of Merit attained by each Group					Total
	A	B	C	D	E	
1. Pupils above grade in both comprehension and rate	12(8)	26(25)	35(35)	21(20)	4(8)	100
2. Pupils above grade in comprehension but below grade in rate	4(3)	20(18)	46(43)	26(24)	3(10)	100
3. Pupils below grade in comprehension but above grade in rate	0(0)	3(2)	16(12)	44(40)	36(46)	100
4. Pupils below grade in both comprehension and rate	0(0)	4(5)	24(22)	43(41)	29(32)	100

Intelligence quotients.-- On March 4, 1947, all pupils concerned in this study were given the Otis Quick-Scoring Mental Ability Tests, Beta Test: Form A, for Grades 4 - 9. The distribution of intelligence quotients obtained in this test is given in figure 1.

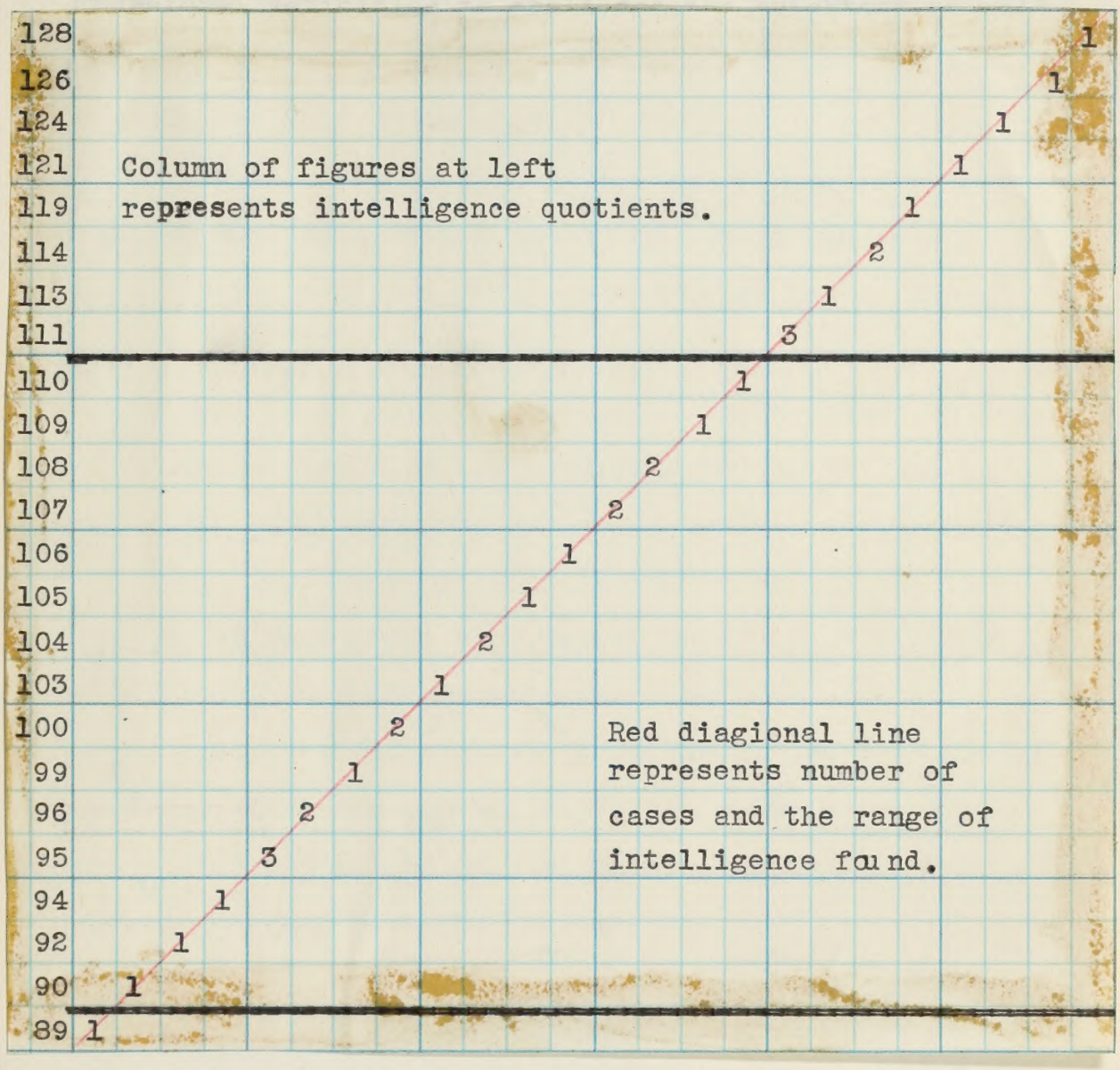

Figure 1. Distribution of Intelligence Quotients as Obtained on the Otis Quick-Scoring Mental Ability Test.

The range of intelligence quotients in the group is from 89 to 128, and the median is found to be 107. Therefore, activities to challenge the brightest as well as those which are not too difficult for the slowest must be included in the unit assignments.

A few discrepancies were evident in the group test results but these were remedied by having the school psychologist administer individual Binet Mental Tests. In the five cases studied the pupils were found to be on an average of four points higher in the Binet rating.

At the time that the test referred to in Table 6 was given the range was 2 years 11 months and the median was 6.6. The study of grade status shows that 26 of the pupils were above their grade level and 8 pupils were slightly below their grade level. It must also be remembered that these pupils were tested prior to coming to the sixth-grade and with all things being equal, testing at the outset of the current school year would reveal a higher level by four months.

Table 6. Grade Status as Determined by the Metropolitan Achievement Tests, Intermediate Battery--Partial Form D, revised, for Grades 4, 5, and 6

Grade Level	Number of Pupils	
	Boys	Girls
8.1		1
7.5		1
7.2		1
7.1	1	
7.0		2
6.8		2
6.7	2	3
6.6	1	3
6.5	1	2
6.4	1	2
6.2	3	
6.0	1	
5.9		1
5.7	1	
5.6	1	
5.5	2	
5.3	1	
5.2		1
Totals	15	19

Interests and abilities.--A study of the interests and abilities of a group is an aid to the selection of functional subject matter,[1/] and some of the personal data in Table 7 will make possible the adaptation of the work to individual interests.

Table 7. Out-of-School Activities Listed by Pupils

Activities	Number of Pupils
Movies, Radio, Reading	all
Dancing lessons	34
Football	32
Camp cooking	30
Skiing	29

1/ Winifred Margaret Burns, Unit Organization of Two Topics In Occupations, Unpublished Service Paper, Boston University, 1947, p. 7.

Table 6. Grade Status as determined by the Metropolitan Achievement Tests, Intermediate Battery--Partial Form B, revised, for Grades 4, 5, and 6

Grade level	Number of Pupils	
	Boys	Girls
8.1		1
7.9		1
7.8		1
7.1	1	
7.0		2
6.8		2
6.7	2	3
6.6	1	5
6.5	1	2
6.4	1	2
6.2	3	
6.0	1	
5.9		1
5.7	1	
5.6	1	
5.5	2	
5.3	1	
5.2		1
Totals	15	19

Interests and abilities.--A study of the interests and abilities of a group is an aid to the selection of functional subject matter,[1] and some of the personal data in Table 7 will make possible the adaptation of the work to individual interests.

Table 7. Out-of-school Activities Liked by Pupils

Activities	Number of Pupils
Movies. Radio. Reading	41
Dancing lessons	34
Football	32
Camp cooking	30
Skiing	29

[1] Winifred Hargaret Burns, Unit Organization of Two Topics in Occupations. Unpublished Service Paper, Boston University, 1927. p. 7.

Table 7. (concluded)

Activities	Number of Pupils
Ice Skating	28
Baseball	28
Basketball	25
Girls kickball team	20
Fishing	20
Girl Scouts	20
Stamp collecting club	16
Audubon Society (bird club)	16
Clothes designing	14
Art lessons	12
Sewing	11
Work with chemistry sets	11
Music lessons	11
Post-card collecting	10
Collecting china-animals	10
Model airplane making	8
Coin collecting	7

Space Provisions and Equipment

Transformation of the traditional classroom.--The following changes in the physical features of the room had to be made before the units were presented to the pupils.

The classroom in which the units were taught is average in size (32 feet long and 21 feet wide), and accomodates 35 pupils. There were desks and chairs bolted to the floor. The two last rows of these were removed entirely and replaced with individual-moveable tables and chairs. Two good-sized tables were placed in the room for individual and group study, and demonstration activities.

A science library was organized consisting of the school's reference books, and additional copies were furnished by the teacher and pupils. This collection was placed

Table V. (concluded)

Activities	Number of Pupils
Ice Skating	28
Baseball	28
Basketball	25
Girls kickball team	20
Fishing	20
Girl Scouts	20
Stamp collecting club	15
Audubon Society (bird club)	15
Clothes designing	14
Art lessons	12
Sewing	11
Work with chemistry sets.	11
Music lessons	11
Post-card collecting.	10
Collecting china-animals.	10
Model airplane making	8
Coin collecting	7

in an easily accessible and convenient place at the back of the room so that pupils going to the library would not disturb other members at the front of the room. The text-books were placed on a rectangular table, and in a book trough purposely made for this study, at the front of the room.

A bulletin-board, 57 inches long and 40 inches wide, was constructed and placed at the back of the room where blackboard had previously been.

Six drawers located on the left-hand side at the front of the room were cleaned out and rearranged so that three of these were completely available for the teaching materials necessary in the carrying out of these units. These have been properly labeled to indicate contents in order to save teacher and pupil time.

The room has been equipped during the past summer with translucent and opaque shades on the windows for visual education work. Two obsolete movie cameras were exchanged for modern equipment, including:

1. A Movie Mite,[1] 16 mm sound or silent movie that has among its features a small screen attachment to use for testing new films or for small group-work.

2. A Delineascope[2] opaque projector which reproduces in an excellent manner clippings, pictures from a book, mounted material, or drawings.

1/ Movie Mite Corporation, Kansas City, Mo.
2/ Delineascope, Spencer Lens Company, Buffalo, New York, or Jarrell-Ash Company, Scientific Instruments, Boston, Mass.

3. A large portable screen to use with the foregoing cameras.

4. Four stereographs with a collection of views many of which are pertinent to the units. Pupils were encouraged to make a series of their own.

Integral helpers.--Arrangements were made with the following personnel to lend further success to the teaching of the units:

1. The regular classroom teacher to provide the pupils with help in English or social studies as applicable to their work in the units.

2. The art supervisor to use current topics under study for motivation purposes in art work.

3. The school's custodian in order to allow individual pupils to use the basement workshop for construction of materials pertinent to the units. This arrangement was necessary due to the fact that there is no manual training taught in the school.

4. The head librarian of the town's public library to supply additional materials, such as books and posters, integrated with the unit topics.

Films were ordered from the Visual Aids Department, Boston University, and the Goodyear Tire and Rubber Company during August preceding the teaching of the units.
A small wooden file, made from a discarded chalk box, painted and labelled, "Optional Activities", was strateg-

3. A large portable screen to use with the foregoing cameras.

4. Four stereographs with a collection of views many of which are pertinent to the units. Pupils were encouraged to make a series of their own.

Integral helpers.--Arrangements were made with the following personnel to lend further success to the teaching of the units:

1. The regular classroom teacher to provide the pupils with help in English or social studies as applicable to their work in the units.

2. The art supervisor to use current topics under study for motivation purposes in art work.

3. The school's custodian in order to allow individual pupils to use the basement workshop for construction of materials pertinent to the units. This arrangement was necessary due to the fact that there is no manual training taught in the school.

4. The head librarian of the town's public library to supply additional materials, such as books and posters, interested with the unit topics.

Films were ordered from the Visual Aids Department, Boston University, and the Goodyear Tire and Rubber Company during August preceding the teaching of the units.

A small wooden file, made from a discarded chalk box, painted and labelled, "Optional Activities", was strate-

ically located to hold the optional related activity,[1] 4 inches by 6 inches, cards.

A letter-size filing cabinet was made by the junior-high school manual training classes, for the purpose of storing tests, illustrative materials, mounted pictures and clippings, and pupil's papers, all of which were classified for efficient use.

Permission was received to use the teachers' room for small-group activity work. This room consists of a round table with chairs, a sink with hot and cold water, electric hot-plate with two burners, and convenient storage closets.

The school-department provided a science-kit consisting of a fine 24 inches long, 18 inches wide, and 18 inches deep portable-plywood cabinet, with all the equipment required for the teaching of science units in the upper elementary grades.

Provision was made for many pieces of home-made science equipment to supplement the science kit.

Grade Placement of Topics Chosen

The teaching of science in the elementary school is basic to all science instruction in the program of general education.

1/ Billett, Roy O., Fundamentals of Secondary School Teaching, Houghton Mifflin Co., Boston, 1940, p. 507.

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[1] Hillest, Roy O., Fundamentals of Secondary School Teaching, Houghton Mifflin Co., Boston, 1940, p. 507.

According to the Thirty-First Yearbook Committee,[1] the aim of general education is life enrichment. The Committee states that this goal may be accomplished through an increasing understanding of principles, or generalizations, that have proved most significant in an evolution of the race, and that to wield a vital influence on the development of more effective participation by an enlightened citizenry in the activities of a democratic society.

The Committee further states that science education contributes to this broad aim of general education by emphasizing the importance of "the principles and generalizations that ramify most widely into human affairs".[2] The Thirty-First Yearbook Committee recommends that the curriculum in science, for a program of general education, be organized about principles and generalizations that are functional in the lives of boys and girls.

It is a sound educational principle[3] that students should be introduced to scientific subject-matter and be initiated into its facts and laws through acquaintance with everyday social applications. Adherence to this method is not only the most direct avenue to understanding of science itself but as the pupils grow to the understanding

1/ National Society for the Study of Education, A Program for Teaching Science, Thirty-First Yearbook, Part I. Bloomington, Illinois: Public School Publishing Company, 1932.

2/ Ibid., p. 43-44.

3/ Dewey, John, Experience and Education, New York; The Macmillan Company, 1946, p. 98.

initiated

of the economic and industrial problems of present society.

An effort to validate the principles used in the units.-- As a background in the selection of the topics the writer found the result of an extensive study made by Reek[1/] revealed that the most widely used principles, listed on this page and pages 18, 19, and 20 appeared in the textbooks of the following outstanding science educators:

Beauchamp Series, Discovering Our World, for middle grades IV - V - VI, Scott Foresman & Company, New York, 1937.

Craig, and others, New Pathways in Science, (Primer and books for grades I - VI, Ginn and Company, Boston, 1940.

Frasier, and others, The Scientific Living Series, (Primer and books for grades I - VI, L. W. Singer Company, Syracuse, 1937, 1939.

Knox, and others, Wonderworld of Science, for grades I - VI, Charles Scribner's Sons, New York, 1941.

Principles commonly found and appearing in the units.-- The following principles have been incorporated in the units and appear written at the pupil's level:

1. The pressure of air decreases with an increase in water vapor content, other conditions remaining unchanged.
2. Air presses evenly in all directions. The higher the temperature of the air, the greater the amount of moisture that is required to saturate it.

1/ Doris Lucille Reek, A Study of the Principles of Science Found in Four Series of Textbooks of Elementary Science, unpublished master's thesis, University of Michigan, 1943, p. v + 183.

3. Warm air will hold more moisture than cool air.
4. Warm air is forced upward by the falling, or settling of colder air.
5. When a mass of warm air meets a mass of cold air, the cold air pushes the warm air upward, and clouds form all along the front.
6. Cold air settles toward the earth, pushing up the warm air.
7. When air is heated, it expands and gets lighter. The cold air pushes the hotter, lighter air upward.
8. All living things use air.
9. Animals must breathe oxygen from the air in order to live; plants must have carbon dioxide and oxygen to live and manufacture food.
10. The oxygen of the atmosphere is removed by animals and replaced by green plants.
11. When air is cooled sufficiently, the moisture in it condenses.
12. When there is more water vapor in the air than it can hold at that temperature, the water vapor condenses as rain, hail, dew, fog, snow or sleet.
13. As the warm air rises, it cools. Cool air cannot hold as much moisture as warm air can.
14. As the warm air continues to rise, it becomes cooler, and moisture condenses as rain or snow.
15. The air has moisture in it. When the moisture

is cooled it falls to the earth as rain or snow or fog or sleet.

16. As warm air is pushed up by cool air, it too, becomes cooler. The water vapor which it holds condenses to form clouds.

17. When the air becomes so cool that it can no longer hold all its moisture, the water vapor condenses on the tiny particles of dust that are always in the air.

18. Differences in temperature cause differences in atmospheric pressure, and these differences in atmospheric pressure cause wind.

19. As the atmosphere near the earth heats, it expands. Then cold air pushes down and forces the warm air up. When the cold air changes place with the warm air, a wind is made.

20. The winds are caused by the unequal heating of large quantities of air over snow fields, deserts, and large bodies of water.

21. Air moves from points of greater pressure to points of less pressure, causing air currents, or winds.

22. In a high-pressure area, the winds are blowing away from the center of the area.

23. In a low-pressure area, the winds are blowing toward the center.

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21. Air moves from points of greater pressure to points of less pressure, causing air currents, or winds.

22. In a high-pressure area, the winds are blowing away from the center of the area.

23. In a low-pressure area, the winds are blowing toward the center.

24. When air is in motion, the currents help distribute heat on the earth.

25. Because of the rotation of the earth, the highs and lows move across the earth from west to east.

26. Bodies of land heat up and cool off more rapidly and more readily than do bodies of water.

27. The air forms a blanket around the earth. This blanket of air keeps the earth from losing its heat.

Grade placement of units selected.--Proper grade placement of subject-matter is of infinite importance. The latest textbooks have placed in a suggestive manner both topics, air and aviation, at the sixth-grade level. Francis D. Curtis[1/] places these two topics at upper intermediate-grades. An intelligent appreciation of flying, which is called for want of a better term "air mindedness," may commence,[2/] and the foundations of knowledge about flying may be laid in the sixth grade.[3/] Arey in his chapter on "Suggested Sequence of Learning Elements", also recommends all phases of air and aviation, used in the ensuing units, at the upper-intermediate level.

1/ Francis D. Curtis, Teaching of Science in Grades I Through VI, Review of Educational Research, Volume XII, Number 4, October 1942, p. 369-372.

2/ Arey, Charles K., Air-Age Education Series, Elementary School Science for the Air Age, The Macmillan Company, New York, 1942, p. 3.

3/ Ibid. p. 101-108.

In the Review of Educational Research[1] and the Thirty-First Yearbook of the National Society for the Study of Education, both recommend the study of air at the sixth-grade.

Time allotment.--In the preparation of the units the time element was a strong factor to be considered. Bertha Morris Parker,[2] suggests that for the study of air at this level, ten to twenty hours should be planned. The following units were based on six-weeks duration each, with 30-minute periods daily. This allowed 15 hours for each unit, thus striking a mean based on Miss Parker's recommendation.

The Teaching of the Units

Time allotment.--The presentation of Unit I, Air and You, began on October 27, 1947, and the work continued for a period of seven-and-a-half weeks, five half-hour periods per week. The final objective test was administered on December 17, 1947. Excluding teachers' convention, Armistice Day, the Thanksgiving vacation, and one inclement day, there was a total of 32 half-hour periods.

The teaching of Unit II, Men Fly, started January 5, 1948, with a pre-test administered on that date, and the activities connected with the unit assignment extended over another seven-week period of time. Five half-hour periods per week were allowed, excepting in the case of

1/ Review of Educational Research, Volume XII, Number 4, October 1942, Chapter II.

2/ Bertha Morris Parker, Manual, Basic Science Education Series, Row Peterson and Company, Evanston, Ill., 1941, p. 102-108.

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[1] Review of Educational Research, Volume XII, Number 4, October 1942, Chapter II.

[2] Bertha Morris Parker, manual, Basic Science Education Series, Row Peterson and Company, Evanston, Ill., 1941, p. 102-108.

one assembly, two periods out for art and two days lost due to inclement weather. Thus losing five periods and leaving a total of 30 half-hour periods.

The teaching of the unit was concluded with an original pupil-created assembly presented to the entire school and a large number of parents, presented on February 18, while the final 3-page objective achievement test was administered on February 20. A "pupil's opinion of unit questionnaire" was given at the conclusion of the last objective test. The results of the findings on this questionnaire are found in Chapter IV.

Four phases of the teaching-learning cycle.-- The teaching-learning cycle in the unit method used consists of four phases. The first is introductory.[1/] Here, a study of the individual pupils having been made from the cumulative records, a teacher-built objective test was administered. The items in the test were based upon the statements of the units and their delimitations. Following the test, activities intended to interest and challenge all pupils and make them feel that they were about to engage in something worth-while were introduced.

The second phase is the laboratory period.[2/] Study guides were distributed and the pupils planned therefrom

1/ Billett, Roy O., Fundamentals of Secondary School Teaching, Houghton Mifflin Company, Boston, 1940, p. 599.

2/ op. cit., p. 600.

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[1] Hillett, Roy O., Fundamentals of Secondary School Teaching. Houghton Mifflin Company. Boston. 1940. p. 597.

[2] op. cit., p. 600.

their activities for several class periods. As need arose the teacher worked with individuals, small groups, or with the entire class. During this stage a log of pupil-reactions and teacher-observations was kept. Revisions and adjustments in the unit assignment were made as a result. At the conclusion of this phase each pupil wrote an objective summary of what he had learned and how he felt about the method of this study.

The pooling-and-sharing of experiences phase[1] is the third step in the teaching-learning cycle. The pupils shared the results of their study, reports of findings and committee work were given, exhibits explained, experiments performed, and a general summary of the unit made. Part of this work was programmed and conducted by pupil chairmen and part was teacher-conducted. Five class periods were devoted to the pooling-and-sharing of experiences phase.

The final phase of each unit was concerned with estimating the educative growth of each pupil.[2] During this phase very extensive objective teacher-made tests were administered. All pertinent facts were brought together in interpreting the results of the final tests and are presented in Tables 8 and 9. All other objective findings are described in detail in Chapter IV and in the Appendix.

1/ op. cit., p. 602

2/ op. cit., p. 602-603.

Table 8. Initial Test Scores, Final Test Scores, and Number of Points Gained on the Objective Tests for Unit Air and You

Pupil	Initial Test Score	Final Test Score	Points Gained
1	70	80	10
2	70	50	-20
3	70	64	- 6
4	70	72	2
5	60	82	22
6	55	76	21
7	50	44	- 6
8	75	86	11
9	75	78	3
10	90	90	0
11	80	92	12
12	70	60	-10
13	70	68	- 2
14	72	75	3
15	60	68	8
16	60	80	20
17	70	84	14
18	65	90	25
19	60	60	0
20	70	72	2
21	70	78	8
22	60	48	-12
23	80	82	2
24	60	64	4
25	75	86	11
26	80	85	5
27	80	80	0
28	80	94	14
29	65	88	23
30	80	92	12
31	75	86	11
32	75	88	13
33	70	82	12
34	80	85	5

The average number of points gained was 6.97

There was no initial pre-test given to the pupils for Unit II, Men Fly, due to the fact that the unit on air led directly into the study of aviation and it was felt

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The average number of points gained was 6.97

There was no initial pre-test given to the pupils for Unit II, Men Fly, due to the fact that the unit on air led directly into the study of aviation and it was felt

unnecessary as an introductory activity. The class was given a mid-unit objective test and also a final objective test with the results tabulated in Table 9. Points gained by each pupil are also shown.

Table 9. Mid-Unit Test Scores, Final Test Scores, and Number of Points Gained on the Objective Tests for Unit Men Fly

Pupil	Mid Test Score	Final Test Score	Points Gained
1	68	76	8
2	62	58	- 4
3	74	78	4
4	60	68	8
5	82	84	2
6	80	85	5
7	66	78	12
8	82	88	6
9	88	94	6
10	86	92	6
11	84	82	- 2
12	70	74	4
13	58	68	10
14	76	78	2
15	70	74	4
16	58	56	- 2
17	70	66	- 4
18	70	74	4
19	56	68	12
20	52	56	4
21	70	74	4
22	50	58	8
23	80	72	- 8
24	60	66	6
25	82	84	2
26	62	68	6
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The average number of points gained was 4.44.

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CHAPTER II

AIR AND YOU

General statement of the unit.[1] -- Air is one of the commonest things in the world, in fact we are living at the bottom of an invisible ocean of air which is composed of a real substance. Wherever you go on land or sea you are always surrounded by air. The substance fills every crack and crevice, exerting pressure upon all parts of the earth's surface. We are completely bathed by air from birth to death.[2] We live in it, move in it, and grow old in it. Fortunately we do not have to buy this vital substance, for it exists in great quantities right at our very nostrils, ready to rush into our lungs at all times.

Man has learned to use the pressure of the air and the property of the compressibility of the air to do work for him. The air is composed of many gases, which have specific uses for life on earth. The atmosphere gives man the wind, temperature, and humidity which are so essential for the existence of life. The atmosphere is necessary for the gradual cooling and heating of the

1/ Billett, op. cit. p. 505.

2/ Gerald S. Craig, Science for the Elementary-School Teacher, Ginn and Company, Boston, 1940, p. 180.

surface of the earth by the sun. Life[1] would probably be impossible without the atmosphere because the earth would by very hot in the daytime due to the heat of the sun and would freeze during the nightime because of the rapid radiation of heat most of which is now held near the earth by the atmosphere.

Approximate time allotment -- 30 periods of 30 minute length.

Delimitation of Unit.--[2]

1. The air forms a blanket around the earth. This blanket of air keeps the earth from losing its heat.
    (a) The atmosphere extends at least 200 miles above the surface of the earth.
2. Air is a mixture composed of about 21 percent oxygen, 78 percent nitrogen, and 1 percent carbon dioxide, inert gases, dust, smoke, water vapor, and other substances.
    (a) A material which has reached its burning temperature will burn so long as oxygen is supplied and the material lasts.
    (b) Carbon dioxide composes about three-

1/ Arthur J. Giovannangeli, Unit Organization of Three Topics in Seventh-, and Eight-Grade General Science with Special Reference to the Supervision of Cadet Teachers, Unpublished Master's Thesis, Boston University, 1939.

2/ Billett, op. cit. p. 505.

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1/ Arthur A. Glovannengli, Unit Organization of Three Topics in Seventh-, and Eighth-Grade General Science with Special Reference to the Supervision of Usual Teaching Unmodified Master's Thesis, Boston University, 1934.

2/ Billett, op. cit. p. 505.

hundredths of one percent of the air and is necessary for plant life.

(c) The presence of carbon dioxide in the air we breathe is not nearly so dangerous as the presence of a small quantity of carbon monoxide. Carbon monoxide is the gas which has killed so many people who carelessly run an automobile motor in a closed garage. When a little carbon monoxide is breathed it joins with the iron in the red blood cells and this prevents oxygen from joining with that iron, therefore a person suffocates because there is no way the oxygen can get from the lungs to the blood stream into the body cells where it is to be used.

3. Air has weight. Weigh a football before and after inflating it with air. The difference in the weights of the football is the weight of the air which was in the football.

4. When air is cooled sufficiently, the moisture in it condenses.

(a) When there is more water vapor in the air than it can hold at that temperature, the water vapor condenses as rain, sleet, hail, dew, frost, fog, or snow.

5. When air is heated, it expands and gets lighter. The heavier cold air around the heated air pushes the lighter warm air upward. As the light warm air is pushed upward it is cooled and the moisture in it condenses to form a cloud out of which rain may fall.
6. The region where a mass of warm air and cold air meet is called a front. A front along which there is little or no movement of air is called a stationary front. A front along which there is considerable mixing of warm and cold air is called an occluded front. When a cold air mass pushes a warmer air mass horizontally, the front between them is called a cold front. When a warm air mass pushes a colder air mass horizontally, the front between them is called a warm front.
7. A heavy mass of cold air moving horizontally may go under a lighter mass of warmer air and force the warmer air upward along a cold front which slants backward above the mass of cold air. As the warm air containing moisture is pushed higher, it becomes cooler and finally the moisture in the air condenses to form clouds out of which rain or some other form of precipitation may fall. Clouds form all along the front. Fair weather usually follows after the cold front has passed.
8. A mass of cold air may push a mass of warmer air

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9. Air moves from areas of greater pressure to areas of lesser pressure, causing air currents called winds.

   (a) In a high-pressure area, the winds blow away from the center of the area, and in a clockwise direction.

   (b) In a low-pressure area, the winds blow toward the center of the area, and in counter-clockwise direction.

   (c) Atmospheric pressure can be measured with a barometer.

   (d) When air is in motion, the currents of air help distribute heat on the earth.

   (e) Because of the rotation of the earth the "highs" and "lows" usually move across the earth from west to east in the northern hemisphere.

10. The exact temperature of the air can be determined by a thermometer.

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(c) Atmospheric pressure can be measured with a barometer.

(d) When air is in motion, the currents of air help distribute heat on the earth.

(e) Because of the rotation of the earth the "highs" and "lows" usually move across the earth from west to east in the northern hemisphere.

10. The exact temperature of the air can be determined by a thermometer.

(a) More heat causes the liquid in the thermometer to expand and less heat or cold causes the liquid to contract.

(b) Two thermometer scales are in use. In this country for ordinary use, the Fahrenheit scale is used. It has two fixed points: The boiling point of water which is 212 degrees Fahrenheit and the freezing point of water which is 32 degrees Fahrenheit.

(c) On the Centigrade scale which is mostly used in laboratory and research work, 100 degrees Centigrade is the boiling point of water and zero (0) degrees Centigrade is the freezing point.

11. Air exerts pressure on surfaces because of its weight. A few of the devices which make use of air pressure are the medicine dropper, the self-filling fountain pen, the lift-pump, and the siphon.

(a) The underlying principle of these devices is to lessen the air pressure inside of the cylinder which is connected to the liquid, thereby causing the greater air pressure outside of the cylinder to push the liquid toward the place inside the

cylinder where the air pressure is less.

(b) A siphon is a bent tube that is used for conveying a liquid upward, across, and then down to a lower level. The bent tube must be completely filled with liquid; also, the end of the short arm must be under the surface of the liquid in a vessel. When the liquid in the long arm starts to fall, the air pressure pushes water from the vessel toward the area in the long arm from which the water flows out. Air pressure on the surface of the liquid in the vessel causes more liquid to enter the tube, as long as the opening at the end of the short arm of the tube is below the surface of the liquid.

12. Compressed air exerts an outward pressure on all parts of its container.

(a) Compressed air is used for common devices such as tires, doorchecks, air-brakes of cars and trains, pneumatic hammers and drills, and the bicycle pump. Air is also used to keep water out of caissons, to float submarines and in de-icers on the wings of airplanes.

13. Bodies of land heat up and cool off more rapidly and more readily than do bodies of water.

14. The air is used for transportation by means of airplanes.

Probable indirect and incidental learning products.[1] --

1. A fuller appreciation of man's dependence upon air for life, and for more comfortable living.
2. An attitude of indebtedness for the countless number of machines employing principles involving air.
3. An understanding of factors involving air which affect daily living indirectly.
4. Ability to read and interpret weather instruments and maps.
5. Overcoming superstitions relating to "signs of the weather".
6. Ability to recognize the common cloud formations and to foretell coming weather.

References for Teachers' Use

Caldwell, Otis W. and Francis D. Curtis, Science for Today, Ginn and Company, Boston, 1936, Unit I, chapters II - III, The Air and Some of Its Uses, p. 17-55. Chapter XIII, Useful Knowledge About the Weather, p. 224-249.

Davis, Ira C., and Richard W. Sharpe, Science, Henry Holt and Company, New York, 1947. Chapter 2, How has Man Learned to use Air Pressure? p. 27-57. Chapter 5, How has Man Learned the Causes for the Changes in Weather and Climate? p. 113-139.

Fuller, Robert W., Raymond B. Brownlee, and D. Lee Baker, First Principles of Physics, Allyn and Bacon, Boston, 1942.

1/ Billett, op. cit. p. 506.

14. The air is used for transportation by means of airplanes.

Probable interest and intended learning products.[1]

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Fuller, Robert W., Raymond B. Brownlee, and D. Lee Baker. First Principles of Physics. Allyn and Bacon, Boston. 1934.

[1] Millett, op. cit. p. 506.

Chapters:
IV Floating and Submerged Bodies p. 65-77.
VI The Atmosphere and Its Pressure p. 92-114.
VII Boyle's Law and Compressed Air p. 114-129.
XXXIX The Automobile and the Airplane, p. 766-795.

Hausrath, Alfred H., Jr. and John H. Harms, Consumer Science, The Macmillan Company, New York, 1940.
Chapter VII, Machines That Use Air, p. 95-102.

Nettels, Charles H., Paul F. Devine, Walter L. Nourse, and M. E. Herriott, Physical Science, D. C. Heath and Company, Boston, 1942.
Chapter 1, The Weather p. 1-37.
Chapter 2, The Air, p. 37-63.

Watkins, Ralph K., and Winifred Perry, Science for Human Control, The Macmillan Company, New York, 1940.
Unit Three, Our Attempts to Rule the Air, p. 83-137.

Wood, George C., and Harry A. Carpenter, Our Environment, How We Use and Control It, Allyn and Bacon, Boston, 1942. Topic III, How Air Works for Man, p. 93-141.
Topic IV, Air, Fire, and Living Things, p. 141-181.

The Unit Assignment[1]

A. One or more of the following introductory activities:

1. The unit is introduced by reading the paragraph entitled "A Riddle", p. 3-4, in The Air About Us, Basic Science Education Series, by Bertha Morris Parker, Row Peterson Company, 1941. Let the pupils try to guess the answer, and allow for a short discussion of the comments made.

2. The teacher gives the pupils a questionnaire of the true-false and completion type in order to discover what they already know about the subject matter of the unit.

1/ Billett, op. cit. p. 506.

Chapters:
IV Floating and submerged Bodies p. 65-77.
VI The Atmosphere and Its Pressure p. 92-114.
VII Boyle's Law and Compressed Air p. 114-129.
XXXIX The Automobile and the Airplane. p. 766-793.

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2. The teacher gives the pupils a questionnaire of the true-false and completion type in order to discover what they already know about the subject matter of the unit.

1/ Millett, op. cit. p. 506.

3. Further clues as to the interests, lack of knowledge, or incorrect knowledge of the pupils on this topic are determined by asking pupils to contribute questions about "air" to a question box.
4. The teacher hands out the general study and activity guides.
5. The teacher hands out pupils' reference list.

Questionnaire for "Air and You"

The teacher administers the ensuing questionnaire which includes some of the principles pertinent to the unit, Air and You.

Section I--True-False Items

Directions for true-false items: Read each statement carefully. If you believe the statement to be true, underline "T". If you believe the statement to be false, underline "F".

T F 1. Air is all about us.

T F 2. We could live without air.

T F 3. Air is visible.

T F 4. Streamlined objects are made so that they can move through the air easily.

T F 5. We can feel air as it is moving.

T F 6. If we should go up in a balloon 15 miles above the surface of the earth, there would still be air around us.

T F 7. We must have air in order to live.

T F 8. Birds, Dogs, and trees do not need air.

T F 9. Air presses up and down and sideways.

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T F 8. Birds, bugs, and trees do not need air.

T F 9. Air presses up and down and sideways.

T F 10. A volume of warm air is heavier than the same volume of cold air.

Section II--Completion Items

Directions for completion items: Complete the following statements correctly by filling in each blank with one word from the list of words below.

expand	gases
thermometer	space
motion	vapor
contract	dust
fish	clouds
compound	water

1. Air takes up (space) even though it is invisible.
2. Wind is air in (motion).
3. Air is made up of several (gases).
4. We use (thermometers) to find out how hot or cold anything is.
5. Almost all materials (expand) when heated and (contract) when cooled.
6. There is always some water (vapor) in the air.
7. (Fish) come to the top of the water for air.
8. (Clouds) are made up of drops of water or crystals of ice.
9. Particles of (dust) are found in the air.
10. When water vapor is cooled, it may change to drops of (water).

T F 10. A volume of warm air is heavier than the same volume of cold air.

Section II--completion Items

Directions for completion items: Complete the following statements correctly by filling in each blank with one word from the list of words below.

expand	gases
thermometer	mass
motion	vapor
contract	dust
fish	clouds
compound	water

1. Air takes up _____ even though it is invisible.

2. Wind is air in _____.

3. Air is made up of several _____.

4. We use _____ to find out how hot or cold anything is.

5. Almost all materials _____ when heated and _____ when cooled.

6. There is always some water _____ in the air.

7. _____ come to the top of the water for air.

8. _____ are made up of drops of water or crystals of ice.

9. Particles of _____ are found in the air.

10. When water vapor is cooled, it may change to drops of _____.

A purpose for activities in the unit assignment.

Intelligent activity[1] is distinguished from aimless activity by the fact that it involves selection of means - analysis - out of the variety of conditions that are present, and their arrangement - synthesis - to reach an intended aim or purpose. The pupil's activities[2] are given direction only by some goal which he seeks to attain. The assignment should obviously create situations in which pupils will find goals having a conscious[3] problem-solving activity and hence teaching takes place with reference to some goal which if valid is statable in terms of some desirable advance in the educative growth of the pupils.

Core activities

Class discussion and individual procedure.

1. The teacher makes use of a globe of the earth and asks the following questions: How much of the earth is covered with water? How much of the earth is covered with land? How much of the earth is covered with air? Teacher then draws a circle representing the earth on the blackboard and has a pupil line off space taken up by land, water and air.

1/ John Dewey, Experience and Education, New York: The Macmillan Company, 1946, p. 105-106.

2/ Roy O. Billett, Fundamentals of Secondary-School Teaching, Boston: Houghton Mifflin Company, 1940, p. 174.

3/ Ibid, p. 138.

Individual and small-group work. (The following mimeographed study and activity guide[1] is handed out to the pupils)

A. Read this study and activity guide carefully. Check (✓) the items which interest you most. Can you think of any other really interesting things which might be done in connection with the unit? If so, be sure to let your teacher know. If at any later time you should think of any interesting activity not listed below, consult your teacher about the possibility of using it in this unit.

1. How deep is our ocean of air? Give the names of the different layers of air? (1:106-107) (2:199-200) (8:37) (9:508)[2].

2. What is the great heating force for the earth? Are all materials heated alike by this force? Why Not? The teacher uses Figure 2 and the following questions for discussions: Why is the temperature at the surface of the soil greater than at three feet down? How do you explain the difference in temperature at the surface of soil and at the surface of the water? Why is the water three feet below the surface warmer than the soil three feet

1/ Billett, op. cit. p. 508.

2/ The numbers in each set of parentheses refer to a book and pages therein. The books are listed in the Pupil Reference List, p. 54 and 55.

below the surface? Why is the water at the surface warmer than the water below? When does the sun give more heat at your home, at noon on June 21 or noon on December 21? When does the earth get more heat from the sun, on June 21 or on December 21? Why? Why do you wear white clothes in the summer and dark clothes in the winter? What happens to the air as it cools? What results from the cooling and rising of air currents? (3:42-52) (1:44-53).

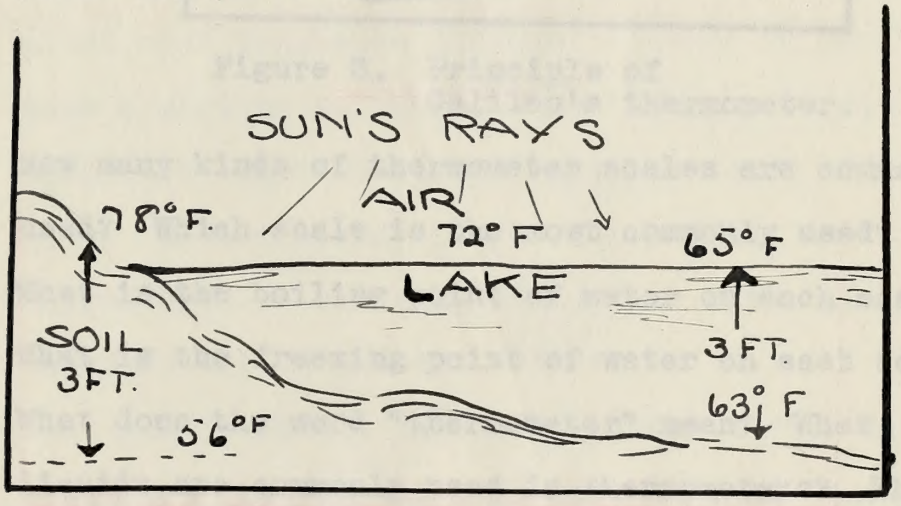
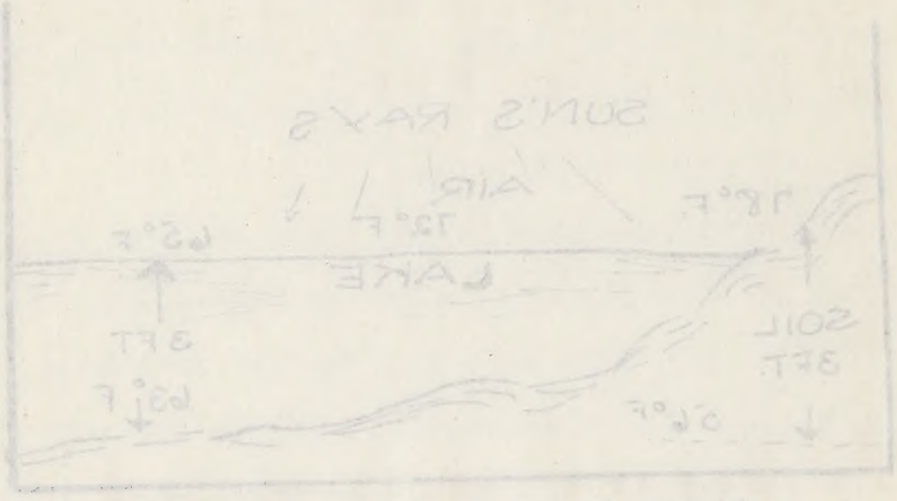


Figure 2. Does the sun heat different materials differently?

3. Demonstration: Galileo's thermometer (Figure 3). Teacher performs this experiment first. Get a glass beaker and fill two-thirds full of water colored red, place a quarter-inch glass tube twelve inches in length into the water. Draw a thermometer scale and place this in the background. Next heat the water in the beaker; then allow the water to cool. What happens to the column of



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water in the glass tube as the water in the beaker is heated? Why? As the water in the beaker is cooled? Why?

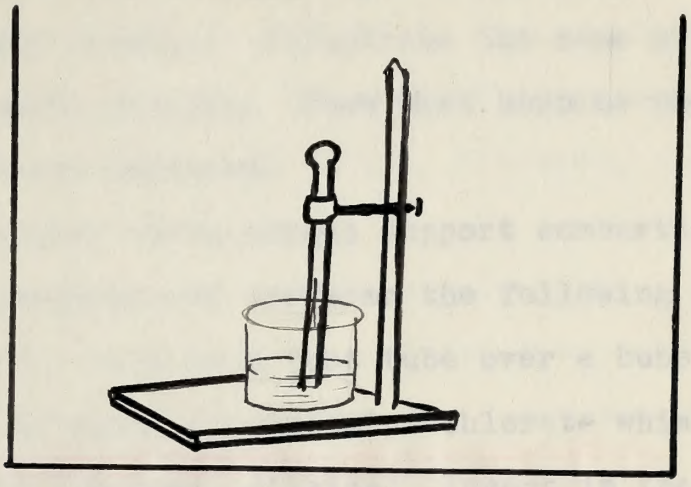

Figure 3. Principle of Galileo's thermometer.

4. How many kinds of thermometer scales are commonly used? Which scale is the most commonly used? What is the boiling point of water on each scale? What is the freezing point of water on each scale? What does the word "thermometer" mean? What liquids are commonly used in thermometers? Why isn't air used in thermometers? (4:31) (5:4-20) (6:107-109) (20:14-15)
5. What is air made up of? What percent is there of each of the common gases in air? What gas do you inhale? What gas do you exhale? (1:118-119) (7:49-50) (2:173-177)
6. What common gas do fires need to keep them burning? (6:154-160) (1:118) (19:31-34)

7. Demonstrations: Teacher shows how a burning candle will go out when placed in a drinking glass covered with something through which air cannot pass readily. Illustrate the same principle in a kerosene lantern. Show what happens when air vents are employed.
8. Demonstration: Does oxygen support combustion? Teacher prepares and performs the following experiment. Heat in a test tube over a bunsen burner a spoonful of potassium chlorate which is mixed with manganese dioxide. Insert in the test tube a glowing splinter. What happens to the splinter? Why? Insert a splinter which has no glow. What happens? Why? What effect does oxygen have on burning? From this fact, what is one sure way to put out a fire?
9. What gas is deadly and often confused with carbon dioxide? What is the most dangerous thing a man can do while he has his automobile in the garage? Why? Why does carbon monoxide act so quickly in suffocating the victim? Where else is carbon monoxide found? (8:175-176) (19:37)

   If you noticed a person who was being overcome with carbon monoxide gas what would you do? Is the Oxygen tent or iron lung used in hospitals today of any help in this case?

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If you noticed a person who was being overcome with carbon monoxide gas what would you do? Is the oxygen tent or iron lung used in hospitals today of any help in this case?

10. What other gases besides carbon dioxide, oxygen, and nitrogen are in the air? Which of these gases is commonly used for illuminated signs? What is helium used for? (1:119)
11. Make a circle graph five-inches in diameter and show the percentage of oxygen, nitrogen, carbon dioxide, and other gases.
12. Pupil demonstration: Drawing water into a glass from a saucer. A pupil appointed from each group prepares and performs the demonstration shown in Figure 4. Fold a two-inch square piece of newspaper three times. Now, bend the folded paper and float it on the water in the saucer so that one end of the folded paper is out of the water and dry. Light the dry end of the folded paper. Immediately invert the empty water glass over the burning paper into the water which is in the saucer. Did the water rise in the glass? If so, why? Why did the fire go out?

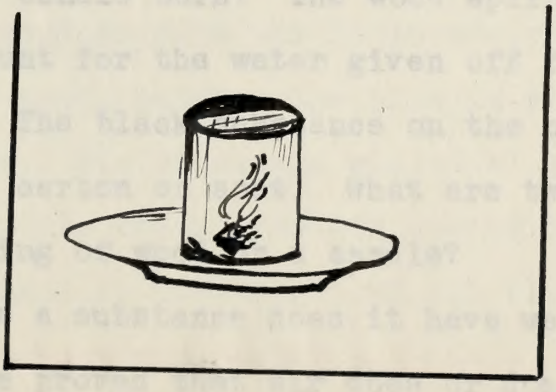

Figure 4. Drawing water into a glass from a saucer.

13. Demonstration to determine if presence of carbon dioxide is present in air? This demonstration is done by the teacher and later by a pupil. Hold the flame of a candle under the mouth of an inverted bottle for a few moments. Note carefully the inside surface of the bottle and observe the water there. Now pour some limewater into this bottle and shake it well. What happens? This is the test for carbon dioxide gas? Hold a lighted wood splint under a second inverted bottle. Do you note the same result as before? Pour in limewater and shake. What happens? Then pour limewater in a bottle of air and shake well? What happens? Is carbon dioxide present in air? Finally hold the lighted candle under a glass plate so that the flame almost touches it. What do you find on the plate? Use the burning wood splint in the same way. What happens? What gas made the candle burn? The wood splint? How can you account for the water given off from the flames? The black substance on the plate is unburned carbon or soot. What are two products of the burning of wood or a candle?

14. If air is a substance does it have weight? How can it be proved that air does or does not have weight? (1:110-111) (10:16-17)

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14. If air is a substance does it have weight? How can it be proved that air does or does not have weight? (J:110-111) (10:16-17)

15. Experiment: Does air have weight? The teacher uses a football which is filled with air and weighs the football on a balance as in Figure 5.

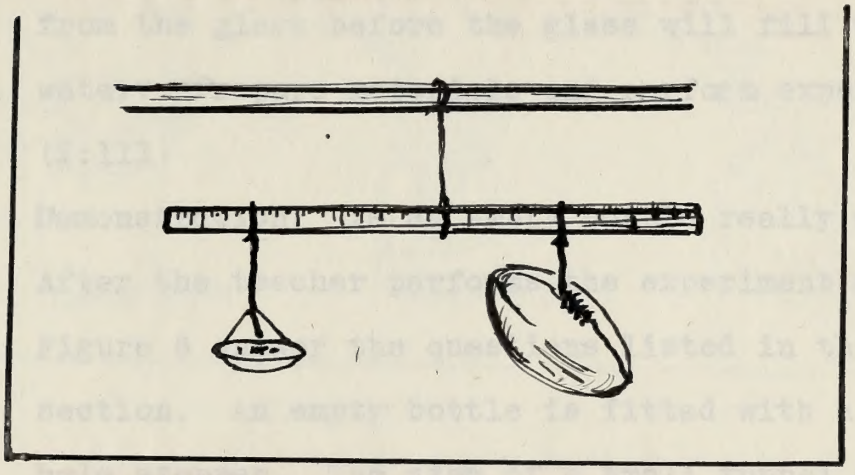

Figure 5. Does air have weight?

The football is then deflated and weighed again. Did the air in the football weigh anything?

16. Pupil demonstration: Weight of air. Cut out a square piece, one inch on a side, from a fairly thick board. Then weigh 15 pounds of books. Place your hand on the table, palm upward. Lay the square of wood on the palm of your hand and get a friend to pile the 15 pounds of books on the block of wood, holding the pile in place if necessary. The 15 pounds will feel quite heavy when they are resting on one square inch. Is this weight equal to the weight of all air above a square inch at sea-level?

17. Is an "empty" glass really empty? If not, why not? Why can't you fill a glass of water when you hold

the mouth of the glass perpendicular to the surface of water? The teacher demonstrates this to the class. What must be allowed to escape from the glass before the glass will fill with water? Prepare materials and perform experiment. (1:111)

Demonstration: Is an empty bottle really empty? After the teacher performs the experiment shown in Figure 6 answer the questions listed in this section. An empty bottle is fitted with a two-hole stopper. The stem of a small funnel passes through one of the holes and a bent glass tube through the other. Both fit the holes tightly. The end of the glass tube is closed by holding a finger over it, and water is being poured into the funnel. (a) Does the water flow into the bottle? (b) What do you think is the reason for the action of the water? The following questions are to be answered after the finger has been removed from the end of the glass tube. (c) What happens to the water when the finger is removed? (d) What reason can you give for the action of the water in this case? A lighted candle is placed near the open end of the delivery tube while water is poured into the funnel. (e) What happens to the candle flame? (f) Where does the air come from?

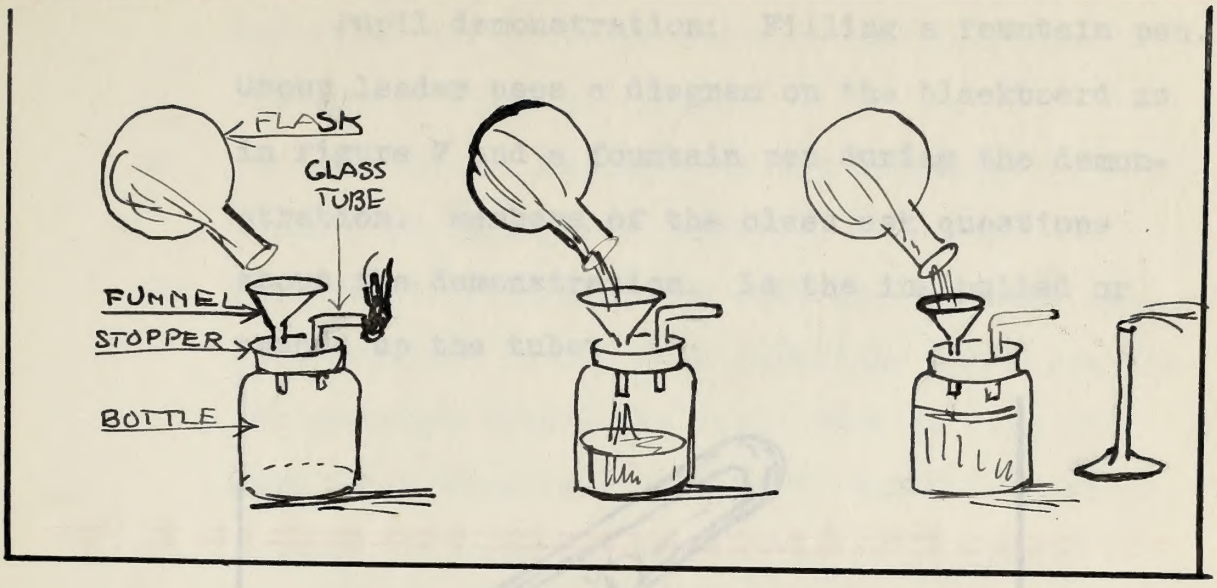

Figure 6. Is an empty bottle really empty?

18. Does air exert or make a pressure? Can you prove this? How? Is air compressible? If so, How? What previous experiment proved that air is compressible? (4:37-38) (11:26-29)
Demonstration: Air makes a pressure and is compressible. The teacher blows up a balloon. Questions directed to the pupils. Is air being compressed? Why do the sides of the balloon stay out? Does air exert pressure?
19. What are some common uses of compressed air? List them on paper. (1:112) (10:18) (11:29-35)
20. Demonstration: Operation of the soda straw. Why does the soda come up the straw? Is soda pulled up the straw, or forced up?
21. How many own a fountain pen? How does the ink get in the tube of the fountain pen?

Figure 8. Is an empty bottle really empty?

18. Does air exert or make a pressure? Can you prove this? How? Is air compressible? If so, how? What previous experiment proved that air is compressible (4:37-38) (11:26-29)

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Pupil demonstration: Filling a fountain pen. Group leader uses a diagram on the blackboard as in Figure 7 and a fountain pen during the demonstration. Members of the class ask questions about the demonstration. Is the ink pulled or pushed up the tube?

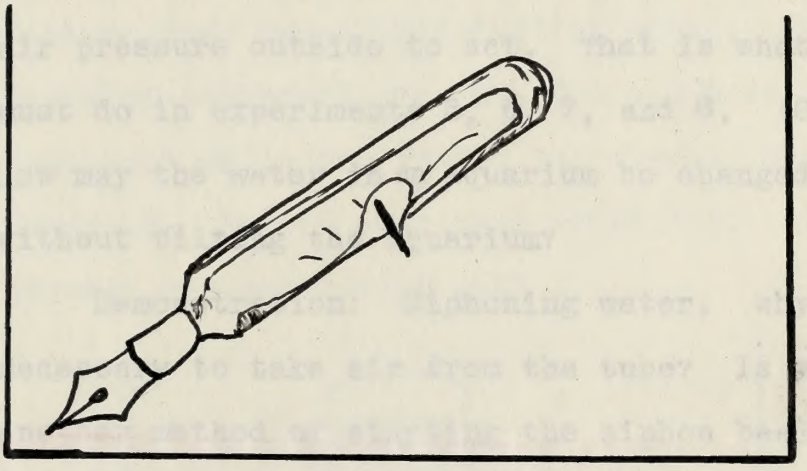
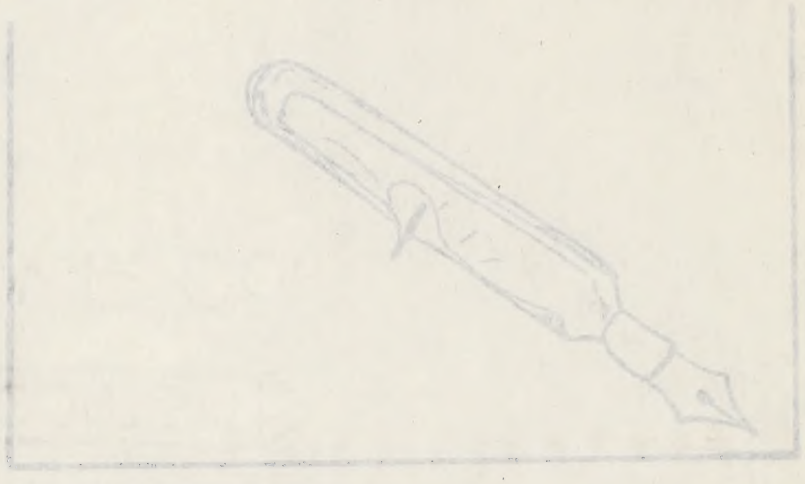


Figure 7. Operation of a fountain pen.

22. Demonstration: Uses of the soda straw. Place a soda straw vertically into a glass full of colored water. Cover the top opening of the straw with a finger and draw up the straw. Does the water stay in the straw? Why? Remove the finger from the top opening of the straw, what happens? Why?
23. Demonstration: The eyedropper. Operate the eyedropper by using colored water in a glass. What is the principle of the eyedropper? (13:32)
24. Demonstration: The operation of a bicycle pump. Take the pump apart and explain the use of the



important parts to the class. Use blackboard diagrams. (12:120) (13:28)

25. Demonstration: Demonstrate the principle of the force cups (plunger). (12:114)

26. To show air pressure, one must usually make the pressure less inside some container and allow the air pressure outside to act. That is what you must do in experiments 5, 6, 7, and 8. (8:45-46)

27. How may the water in an aquarium be changed without tilting the aquarium?

    Demonstration: Siphoning water. Why is it necessary to take air from the tube? Is there another method of starting the siphon besides drawing the air out of the tube? How? Will a siphon operate if both containers are at the same level? Why? (10:13-15) (1:113-114) (13:33-34)

28. How much does the air in this classroom weigh? Estimate the weight then compute the answer on the basis that one cubic foot of air weighs about one and one-quarter ounces.

29. Differences in air pressure at different heights. The teacher demonstrates air pressure with a pile of six books to represent the air column. The bottom book represents sea level. Using the books as the column of air, the teacher asks, where is

important parts to the class. Use blackboard
diagrams. (12:120) (13:29)

25. Demonstration: Demonstrate the principle of the
force cups (plunger). (12:114)

26. To show air pressure, one must usually make the
pressure less inside some container and allow the
air pressure outside to act. That is what you
must do in experiments 5, 6, 7, and 8. (8:45-46)

27. How may the water in an aquarium be changed
without tilting the aquarium?

Demonstration: Siphoning water. Why is it
necessary to take air from the tube? Is there
another method of starting the siphon besides
drawing the air out of the tube? How? Will a
siphon operate if both containers are at the
same level? Why? (10:13-15) (1:115-114)
(13:33-34)

28. How much does the air in this classroom weigh?
Estimate the weight then compute the answer on
the basis that one cubic foot of air weighs about
one and one-quarter ounces.

29. Differences in air pressure at different heights.
The teacher demonstrates air pressure with a pile
of six books to represent the air column. The
bottom book represents sea level. Using the books
as the column of air, the teacher asks, where is

the air pressure the greatest? Least? Half? What instrument is used to measure air pressure? What are the uses of this instrument? (3:203-204) (12:106-107) (4:39-40) (14:46-47)

30. Demonstration: Air pressure holds water in an inverted glass with the aid of a cardboard cover. Fill a glass two-thirds full of water. Place a piece of cardboard over the top and hold the cardboard while you invert the glass. See Figure 8. Remove your hand carefully. Why doesn't the water flow out?

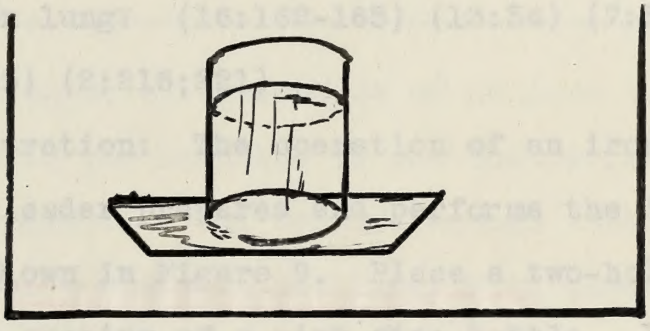


Figure 8. Air pressure with aid of cardboard holds water in an inverted glass.

31. Demonstration: Air pressure forces a hard boiled egg in and out of a milk bottle. Prepare the materials as follows: Boil an egg for ten minutes. Place it in cold water for ten seconds. Shell the egg. Fold a square piece of toilet tissue four times. Light the tissue paper and throw it into a quart milk bottle. Immediately place the egg on the opening of the bottle. The problem is to

see if the egg will go into the milk bottle. What forced the egg in the bottle? How did the lighted paper weaken the air pressure inside the bottle? How can we take the egg out of the bottle by the use of air? (10:19-20) (15:373)

32. The caisson. What is a caisson? How does the caisson work? Perform experiment and describe principles to class. (1:116-117) (10:8-9)

33. Oxygen required in our body. What is the function of oxygen in our body? Why do we sometimes need to have an oxygen tent in a hospital? What is an iron lung? (16:162-165) (13:54) (7:52-53) (12:165) (2:216;221)

34. Demonstration: The operation of an iron lung. Pupil leader prepares and performs the demonstration shown in Figure 9. Place a two-hole stopper in the opening of a pint size bottle. Insert a straight glass tube in one of the holes of the stopper. Fasten a balloon on the end of the glass tube which is in the bottle. The balloon represents a lung. Insert a right angle glass tube two inches into the other hole of the stopper. This second tube represents the bellows which draws the air out of the chamber. In operating the device the pupil draws the air out of the right angle tube. This causes air to rush in the straight tube which, in turn, inflates the balloon.

When the pupil takes his mouth off the glass tube, the lung, represented by the balloon, becomes deflated. The series of inflation and deflation of the balloon represents the breathing of a person lying inside an iron lung.

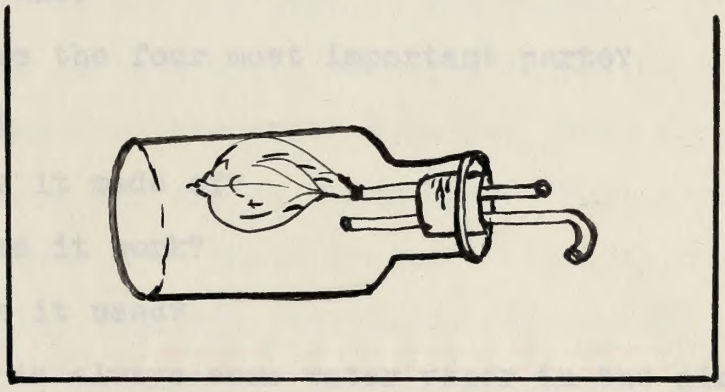


Figure 9. Operation of an iron lung.

35. A trip to the hospital to see the operation of the oxygen tent and the iron-lung. Each pupil is given a mimeographed sheet with questions and is expected to know the answers by the end of the trip.

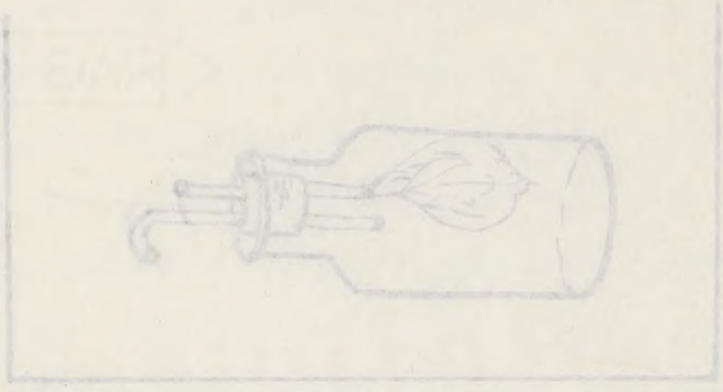
A Trip to the Hospital

You are expected to know the answers to the following questions by the end of the trip.

Iron Lung

1. What is the size of the air chamber?
2. How is the breathing regulated?
3. Why is the collar which is placed on the occupant made of rubber?

Boston University
School of Education
Library



4. Has the occupant of the iron lung freedom of body and heat? What activities can he perform?

5. What is the purpose and use of the iron lung?

6. Who invented the iron lung?

7. What is the cost? Upkeep?

8. If the electricity were shut off would the person inside die?

9. What are the four most important parts?

Oxygen Tent

1. What is it made of?

2. How does it work?

3. When is it used?

36. There is always some water vapor in the air. What happens if the air is cooled? If the air is warmed? How are clouds formed? Why do people call a cloud "dark"? What happens when there is more water vapor in the air than it can hold? (17:3-5) (8:41-42;149-154) (13:102)

37. Tell what "cirrus" clouds look like? How high are they in the sky? What kind of weather do they indicate? (4:43-44) (17:11) (12:563) (14:53-55) (19:69-70)

38. Tell what "cumulus" clouds look like? What nickname is given them? What kind of weather do they indicate? (4:44) (17:5;11) (12:563) (19:69-70) (14:54)

39. Tell what "stratus" clouds look like? What kind of weather can you predict from them? (4:45)

4. Has the occupant of the iron lung freedom of body and head? What activities can be performed?

5. What is the purpose and use of the iron lung?

6. Who invented the iron lung?

7. What is the cost? Upkeep?

8. If the electricity were shut off would the person inside die?

9. What are the four most important parts?

Oxygen Tent

1. What is it made of?

2. How does it work?

3. When is it used?

36. There is always some water vapor in the air. What happens if the air is cooled? If the air is warmed? How are clouds formed? Why do people call a cloud "dark"? What happens when there is more water vapor in the air than it can hold? (17:3-5) (8:41-42;140-154) (13:102)

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39. Tell what "stratus" clouds look like? What kind of weather can you predict from them? (4:45)

(17:10-11) (12:563) (14:53-54) (19:69-70)

40. Tell what "nimbus" clouds look like? What do they indicate? (12:563) (14:53-55) (19:69-70)

41. How do the great winds of the earth circulate? How is it that the air keeps moving and causing winds? Is the air warm at the equator? What happens to this air? In which direction does the cold air from the North Pole go? What happens when warm air and cold air meet? What causes "warm fronts"? "Cold fronts"? (8:154-165) (4:51-54) (13:110) (10:23-24) (20:22-25)

42. How is the speed of the wind measured? What is the instrument called? How can you tell the wind's direction around your neighborhood? (14:48) (12:550) (20:22-25)

43. Name the machines which use air for transportation. How does each machine use air?

List additional findings of your research here:

Vocabulary

gas	cirrus	condensation
compressed	cumulus	currents
barometer	nimbus	cylinder
thermometer	stratus	inflate
siphon	front	exert
Torricelli	caisson	device
Galileo	anemometer	velocity
atmosphere	vapor	pneumatic
drafts	nitrogen	mercury
neon	oxygen	troposphere
carbon dioxide	stratosphere	carbon monoxide
	combustion	

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1. Knox, Warren, George Stone, Morris Meister and Dorothy Wheatley, The Wonderworld of Science, Book 5. Charles Scribner's Sons, New York, 1941.

2. Carpenter, Harry A. and George C. Wood, Our Environment, It's Relation to Us. Allyn and Bacon, Boston, 1946.

3. Craig, Gerald S., Margaret G. Condry, and Katherine E. Hill, From Sun to Earth. Ginn and Company, Boston.

4. Patch, Edith M., and Harrison E. Howe, The Work of Scientists. The Macmillan Company, New York, 1942.

5. Parker, Bertha Morris, Thermometers, Heat and Cold. Row, Peterson and Company, New York, 1942.

6. Beauchamp, Wilbur L., Mary Melrose Williams, and Glenn O. Blough, Discovering Our World, Book 2. Scott, Foresman and Company, New York, 1947.

Vocabulary

gas	cirrus	condensation
compressed	cumulus	currents
barometer	nimbus	cylinder
thermometer	stratus	inflate
siphon	front	exert
Torricelli	celsius	device
Galileo	anemometer	velocity
atmosphere	vapor	pneumatic
Arctic	nitrogen	mercury
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6. Beauchamp, Wilbur L., Mary Melrose Williams, and Glenn O. Blough, Discovering Our World, Book 2. Scott, Foresman and Company, New York, 1947.

7. Beauchamp, Wilbur L., Mary Melrose Williams and Glenn O. Blough, Discovering Our World, Book 1. Scott, Foresman and Company, New York, 1947.

8. Arey, Charles K., Aviation Science for Boys and Girls. The Macmillan Company, New York, 1944.

9. Arey, Charles K., Elementary School Science for the Air Age. The Macmillan Company, New York, 1942.

10. Parker, Bertha Morris, The Air About Us. Row, Peterson and Company, New York, 1941.

11. Huey, Edward G., What Makes the Wheels Go Round. Reynal and Hitchcock, New York, 1940.

12. Wood, George C. and Harry A. Carpenter, Our Environment, How We Use and Control It. Allyn and Bacon, Boston, 1945.

13. Davis, Ira C. and Richard W. Sharpe, Science. Henry Holt and Company, New York, 1943.

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17. Parker, Bertha Morris, Clouds, Rain, and Snow. Row, Peterson and Company, New York, 1941.

18. Parker, Bertha Morris, What Things Are Made Of. Row, Peterson and Company, New York, 1941.

19. Clark, John S., Frederick L. Fitzpatrick and Lillian Edith Smith, Science on the March, Book I. Houghton Mifflin Company, Boston, 1943.

20. Clark, John S., Frederick L. Fitzpatrick and Lillian Edith Smith, Science on the March, Book II.

21. Love, Curtis, John S. Clark, Workbook- Science on the March. Houghton Mifflin Company, Boston, 1947.

7. Beaubamp, Wilbur L., Mary Melrose Williams and Glenn O. Blough. Discovering Our World, Book I. Scott, Foresman and Company, New York, 1947.

8. Arey, Charles K.. Aviation Science for Boys and Girls. The Macmillan Company, New York, 1944.

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20. Clark, John S., Frederick L. Fitzpatrick and William Edith Smith. Science on the March, Book II.

21. Love, Curtis, John S. Clark. Workbook- Science on the March. Houghton Mifflin Company, Boston, 1947.

Optional Related Activities[1/]

When you have completed the required work, go to the card file and choose one or more of the optional related activities in which you are interested.

Before commencing any of these activities the pupils are to obtain the teacher's approval of the chosen activity. Each activity is typed on a card for the pupils.

1. Condense moisture on the outside of a polished metal can or on the outside of a beaker by placing either dry ice or chipped ice on the inside.
2. Demonstrate to the class how to make fire without using matches. (see Boy Scout Manual)
3. Invert a dampened test tube coated with iron filings in a beaker of water. After a day or two note what fraction of the test tube is filled with water. Give reasons for this.
4. Visit the fire department and tell the class about the work of the department. Get information about three types of fire extinguishers: Soda-acid, foamite, and carbon tetrachloride.
5. Explain to the class how an elevator works. Use an encyclopedia for the reference.
6. Make a model to show how we breathe.
7. Report to the class on the use and production of liquid air.

1/ Billett, op. cit. p. 507.

8. Bring into the classroom as many air machines or toys as possible and display them. Explain the operation of each. Pictures and models may be substituted in some cases.
9. Using diagrams, explain to the class how the common lift pump operates. (13:33)
10. Prepare a series of three demonstrations of air pressure which have not been done and do them in class.
11. On a piece of oak tagboard draw clearly the principle of an air conditioning plant. Label all the parts. (1:123)
12. Make an instrument to measure the speed of wind (anemometer). (18:43-44) (20:24)
13. Make a weather vane as shown in (18:52) or (20:24) and explain how it indicates the direction of the wind.
14. Report to the class the difference in breathing of the following: fish, hogs, insects, and birds.
15. Take photographs of things which pertain to the unit and bring these to the class.
16. Explain with the use of diagrams the way a vacuum cleaner works. (6:56-58) (2:170-171)
17. A swinging door moves inward when another door in the room is pulled outward quickly. Explain why?

18. Make three thermometer scales on oak tagboard. a. Galileo's early scale, b. Fahrenheit scale, c. Centigrade scale. (5:8-17) (11:12-14)
19. Keep daily temperature readings for two weeks on a graph. Use graph paper furnished you by the teacher. Take readings at 8:30 AM and 1:00 PM.
20. Bring into the class an atomizer, or construct one. Explain its principle.
21. Demonstrate the following experiment to the class. Put some baking soda in a bottle. Put a little water in the bottle. Pour some vinegar into the bottle. Watch the bubbles of carbon dioxide. Hold a burning match in the opening of the bottle. The carbon dioxide will put out the match. Explain reason.
22. Make a pinwheel and demonstrate it's use. Use directions. (10:26-27)
23. Make a sailboat according to directions. (10:30-31)
24. Find out how your school is ventilated. How is the temperature kept around 70 degrees Fahrenheit in wintertime? How is fresh air admitted?
25. Make a list of new words you have learned while studying this unit. Be sure that their meanings are clear to you.
26. Prepare materials and perform before the class an experiment showing air currents. (6:113-114)

18. Make three thermometer scales on oak tagboard.
a. Galileo's early scale, b. Fahrenheit scale,
c. Centigrade scale. (9:5-17) (11:12-14)

19. Keep daily temperature readings for two weeks on a graph. Use graph paper furnished you by the teacher. Take readings at 8:30 AM and 1:00 PM.

20. Write into the class an absentee, or counterpart one. Explain its principle.

21. Demonstrate the following experiment to the class. Put some baking soda in a bottle. Put a little water in the bottle. Pour some vinegar into the bottle. Watch the bubbles of carbon dioxide. Hold a burning match in the opening of the bottle. The carbon dioxide will put out the match. Explain reason.

22. Make a pinwheel and demonstrate it's use. Use directions. (10:22-27)

23. Make a sailboat according to directions. (10:30-31)

24. Find out how your school is ventilated. How is the temperature kept around 70 degrees Fahrenheit in winertime? How is fresh air admitted?

25. Make a list of new words you have learned while studying this unit. Be sure that their meanings are clear to you.

26. Prepare materials and perform before the class an experiment showing air currents. (6:112-114)

27. Why is there a current in a jar of water when it is heated on one side? Prepare materials and perform the experiment to prove this. (6:108)
28. Do two experiments to show that air takes up space. (7:48-49)
29. Make a collection of the different kinds of clouds. Paste these on a large piece of oak tagboard. Each kind is to be labelled.
30. Collect oxygen in jars. Use potassium chlorate and manganese dioxide. Study and follow directions. (18:16-17)
31. Perform two experiments to show low pressure. (9:45-47) (8:82-85)
32. Make a scrapbook of all your experiments in this unit. Use diagrams, pictures and clippings from magazines, or photographs.
33. Place some chipped ice and salt in a glass. Do crystals condense on the outside from the water vapor in the air?
34. Locate on a map the wind-belts of the world. (20:39-40) On oak tagboard make a drawing showing these wind-belts. (20:37)

The pupils are encouraged to suggest additional pertinent projects and problems which they prefer and, if these are approved by the teacher, may be added to this file.

27. Why is there a current in a jar of water when it is heated on one side? Prepare materials and perform the experiment to prove this. (6:108)

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The pupils are encouraged to suggest additional pertinent projects and problems which they prefer and, if these are approved by the teacher, may be added to this file.

Class Presentation Period

1. The class discussions and comments concerning the conclusion of previous experiments and demonstrations are presented along with the optional related activities. The time needed for this class presentation depends largely on the extent to which pupils have done optional related activities.

2. If any class time remains, it may be used for review of unit principles that are initiated by the pupils.

Evaluative Activities

I. During the course of the laboratory period occasional oral and written tests were given in order to determine whether or not the pupils were mastering the required principles set up for the unit. One of these tests is on page 65.

II. Mastery test of an objective nature given at the completion of the pooling and sharing period of the learning cycle. Each pupil is presented with a mimeographed copy of the following test:

Pupil's Name:_____ Date:_____

Mastery Test on Unit "Air and You"

I. Making the statements correct: Directions. From the list at the bottom of the page choose a word that will make each of the following sentences correct. Write the number of the correct word on the line at the right.

Air can be weighed on a __(1)__ with the aid of __1__ __(6)__ a football.

When air is heated it _(2)_. 2 _(10)_

Man inhales _(3)_ and exhales _(4)_. 3 _(1)_
4 _(9)_

The air pressure is about _(5)_ pounds per 5 _(2)_
square inch at sea level.

The principle of the medicine dropper, lift-pump, and siphon, is to _(6)_ the air pressure 6 _(7)_
in the tube, causing the _(7)_ air pressure to 7 _(11)_
_(8)_ the water up into the tube. 8 _(5)_

As you go up into the earth's atmosphere the air pressure _(9)_. 9 _(3)_

In the lift pump and the bicycle pump _(10)_ 10 _(8)_ are used to control the air.

1. oxygen
2. fifteen
3. decreases
4. carbon monoxide
5. force
6. scale
7. lessen
8. valves
9. carbon dioxide
10. expands
11. outside
12. Galileo
13. thirty

II. True-False: Directions. Read the following statements carefully, if you believe the statement to be true underline the letter "T". If you believe the statement to be false, underline the letter "F".

1. _T_ F Wind has force, and people have learned to put the wind to work.

2. _T_ F Air presses on things on the surface of the earth with great force.

3. T _F_ There are five common thermometer scales in America.

4. _T_ F Oxygen, nitrogen, and carbon dioxide are three of the gases in the air.

5. T _F_ Cold air is lighter than warm air.

When air is heated it (2) .

Men inhales (3) and exhales (4) .

The air pressure is about (5) pounds per square inch at sea level.

The principle of the medicine dropper, lift-pump, and siphon, is to (6) the air pressure in the tube, causing the (7) air pressure to (8) the water up into the tube.

As you go up into the earth's atmosphere the air pressure (9) .

In the lift pump and the bicycle pump (10) are used to control the air.

1. oxygen	7. lessen
2. fifteen	8. valves
3. decreases	9. carbon dioxide
4. carbon monoxide	10. expands
5. force	11. outside
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3. T F There are five common thermometer scales in America.

4. T F Oxygen, nitrogen, and carbon dioxide are three of the gases in the air.

5. T F Cold air is lighter than warm air.

6. T F Water warms up quicker than air.

7. T F Fires need oxygen to keep them burning.

8. T F Carbon monoxide is a very dangerous gas.

9. T F Neon gas which is found in small amounts in air is used for dirigibles.

10. T F Soot is unburned carbon.

11. T F The pressure of air at sea level is fifty pounds per square inch.

12. T F When we inflate our bicycle tires we prove that air is compressible.

13. T F The caisson is an instrument used to measure air pressure.

14. T F When we use a soda straw in drinking the liquid is forced up into the straw and not pulled up.

15. T F We may change the water in an aquarium by using a barometer.

16. T F A siphon is a device used to change water from a higher level to a lower level.

17. T F There is no difference in air pressure at different heights.

18. T F It is possible to force a hard boiled egg into a milk bottle with the aid of air pressure.

19. T F An iron lung is used to replace an injured lung.

20. T F Cumulus clouds are big fluffy clouds.

III. Matching: Directions. Place in the blank at the left the number of the item which it identifies.

(4) centigrade	1. Made the first thermometer.
(3) cirrus	2. An instrument to measure air pressure.
(5) stratus	3. Clouds high above ground that look like curls or mares' tails.
(6) anemometer	

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(4) centigrade 1. Made the first thermometer.

(3) cirrus 2. An instrument to measure air pressure.

(5) stratus

(6) anemometer 3. Clouds high above ground that look like curls or mares' tails.

(7) cumulus	4. Thermometer scale with freezing point of water marked at zero degrees.
(8) Fahrenheit	
(9) nimbus	5. Clouds that are in layers.
(2) barometer	6. An instrument to measure the speed of the wind.
(11) weather vane	7. Large fluffy clouds.
(1) Galileo	8. Thermometer scale with boiling point of water marked at 212 degrees.
	9. Shapeless clouds from which rain falls.
	10. An instrument to measure water vapor.
	11. A wind direction indicator.
	12. Measuring compressed air.

IV. Directions: Read carefully each numbered sentence below. Then read the statements under A, B, C. Make an (X) to the left of the letter of the statement which best agrees with the sentence.

1. The region along which a mass of warm air and cold air meet is called a front.

X A As a result of this the lighter warm air is always pushed upward above the heavier cold air.

__ B The lighter warm air is never pushed upward above the heavier cold air.

__ C The heavier cold air is always pushed upward above the lighter warm air.

2. When air is heated, it expands and gets lighter.

__ A The air will then settle to the ground.

__ B The air will cause an explosion.

X C The heavier cold air around the heated air pushes the lighter warm air upward.

(7) cumulus

(8) Fahrenheit

(9) nimbus

(10) barometer

(11) weather vane

(12) Galileo

4. Thermometer scale with freezing point of water marked at zero degrees.

5. Clouds that are in layers.

6. An instrument to measure the speed of the wind.

7. Large fluffy clouds.

8. Thermometer scale with boiling point of water marked at 212 degrees.

9. Shapeless clouds from which rain falls.

10. an instrument to measure water vapor.

11. a wind direction indicator.

12. measuring compressed air.

IV. Directions: Read carefully each numbered sentence below. Then read the statements under A, B, C. Make an (X) to the left of the letter of the statement which best agrees with the sentence.

1. The region along which a mass of warm air and cold air meet is called a front.

X A As a result of this the lighter warm air is always pushed upward above the heavier cold air.

B The lighter warm air is never pushed upward above the heavier cold air.

C The heavier cold air is always pushed upward above the lighter warm air.

2. When air is heated, it expands and gets lighter.

A The air will then settle to the ground.

B The air will cause an explosion.

X C The heavier cold air around the heated air pushes the lighter warm air upward.

3. The speed, or velocity, of the wind depends;

_A_ upon the direction it comes from.

X B upon the difference in the pressure.

_C_ upon the weather.

4. By removing the air from a gallon tin can;

_A_ the sides of the can will break outward.

X B the sides will crush inward.

_C_ the sides will remain the same.

5. In the siphon experiment we proved that;

X A the air pressure pushes water from the vessel upward into the bent tube.

_B_ the water was drawn downwards because of the air pressure on the lower vessel.

_C_ the water could not be transferred from one vessel to another through a bent tube.

6. Air is a mixture made up of about;

_A_ 78 percent oxygen, 20 percent nitrogen, and 1 percent neon.

_B_ 50 percent oxygen and 50 percent carbon dioxide.

X C 21 percent oxygen, 78 percent nitrogen, and 1 percent of other gases.

7. Materials will burn as long as;

X A oxygen is supplied and the material lasts.

_B_ carbon dioxide is supplied and the material lasts.

_C_ nitrogen is supplied and the material lasts.

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__X A__ oxygen is supplied and the material lasts.

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__C__ nitrogen is supplied and the material lasts.

8. The boiling point of water at sea level on the Fahrenheit thermometer is;

__A__ 100 degrees Fahrenheit.

X__B__ 212 degrees Fahrenheit.

__C__ 32 degrees Fahrenheit.

9. Air exerts pressure on objects

__A__ because of its gases.

__B__ because of its depth.

X__C__ because of its weight and motion of the molecules due to heat.

10. Compressed air is used in all of the following devices;

X__A__ tires, doorchecks, pneumatic hammers, and caissons.

__B__ pneumatic hammers, doorchecks, and vacuum cleaners.

__C__ vacuum bottles, tires, air-brakes, and dirigibles.

Name: _____ Date: _____

Air and You Quiz
Mid-Unit

Part I: True-False: Read the following statements carefully, if you believe the statement to be true underline the letter "T". If you believe the statement to be false, underline the letter "F".

1. __T__ F Air pressure at sea-level is 15 pounds per square inch.

2. T __F__ The stratosphere is the layer of air nearest the earth.

3. __T__ F The sun is the great heating force of the earth.

8. The boiling point of water at sea level on the Fahrenheit thermometer is:

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1. T F Air pressure at sea-level is 15 pounds per square inch.

2. T F The stratosphere is the layer of air nearest the earth.

3. T F The sun is the great heating force of the earth.

4. T F There are two kinds of thermometer scales in use one is the Fahrenheit scale and the other is the Centigrade scale.

5. T F On the Centrigrade scale the freezing point of water is 30 degrees F and 100 degrees F is the boiling point for water.

6. T F The air we breathe has about 76 percent nitrogen, 20 percent oxygen, and 4 percent mixed gases.

7. T F A glowing splint placed into a test tube with heated potassium chlorate and manganese dioxide will burst into flame.

8. T F Carbon dioxide, the gas that comes from the engine of an automobile, is a deadly gas.

9. T F Carbon monoxide is an invisible, tasteless gas and very poisonous.

10. T F Soot made by a flame is unburned carbon.

11. T F There is no water vapor in the air.

12. T F In the football bladder experiment we proved that air has weight.

13. T F In the soda-straw demonstration we proved that the air forced up the liquid.

14. T F Neon gas is used in balloons and dirigibles.

15. T F Limewater is used in the test for carbon dioxide.

16. T F Helium is used in signs on many of our stores and movie theaters.

17. T F In testing for carbon dioxide the limewater will turn milky in color if there is carbon dioxide.

18. T F The higher a person goes up in the sky the more oxygen he finds.

19. T F The atmosphere extends over 200 feet up into the sky.

20. T F There is more air pressure at sea-level than at 30,000 feet altitude.

(turn your paper over until it is collected)

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19. T F The atmosphere extends over 300 feet up into the sky.

20. T F There is more air pressure at sea-level than at 30,000 feet altitude.

(turn your paper over until it is collected)

III. Brief inquiry questionnaire given to pupils to further substantiate evaluation is given at the completion of the unit. A copy of the form is given below.

Pupil's name: _____ Date: _____

Questionnaire about "Air and You"

1. Write in a sentence or two telling what you liked the most about the way we studied this unit.
2. Tell what part of the unit method you liked the least.
3. What did you dislike about this unit.
4. Tell in a few words;
   a. what you found easy in the unit.
   b. what you found difficult in the unit.
   c. what you thought was the most interesting.
   d. what you thought was the least interesting.
   e. what you consider the most useful part of the unit.
   f. what you consider the most useless part of the unit.

Introductory Period

Introduction by the use of group study and pupil demonstration.

The classroom is divided into four groups. A combination of both stationary desks and moveable tables-and-chairs is used to make the laboratory period more effective. The groups are arranged according to activities with a pupil leader in charge, and whatever assistants deem

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necessary. The teacher spends his time circulating among the groups helping where it is most obviously required.

The pupils are expected to perform most of the demonstrations while they are familiarizing themselves with the principles of the unit.

List of materials for use by both teacher and pupils.

aquarium
balloons, toy
beakers, glass
bottles, milk
bottles, large mouth
candles, wax
chimneys, lamp (4)
clamps, test tube
cup, force (plunger)
eyedroppers (4 or 5)
filings, iron
glass, drinking (4 or 5)
" smooth rim
" funnels
" plates
" test tubes
" tubing
jars, large glass
matches
pumps, bicycle (2)
saucers (2 or 3)
splints, wood
stand, ring
stoppers, cork
" rubber (1 hole)
(2 hole)
thistle tubes (4)

Chemicals:
limewater
manganese dioxide
potassium chlorate

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CHAPTER III

UNIT ORGANIZATION OF THE TOPIC
MEN FLY - THE AIRPLANE NOW AND IN THE FUTURE

General statement of the unit.-- Flight has become an important and familiar phase of human activity. In mastering the art of mechanical flight, mankind entered into a new realm of activity, the potentiality of which he still but dimly realizes. The development of the past forty years has brought the flimsy airplane to the mighty airlines of today, but man hardly has begun to use the air.[1/] The unrealized possibilities of flight are literally beyond the scope of man's imagination.

Today, no spot on the earth's surface is more than sixty hours from any other. The ultimate speed, size and load carrying potentiality of aircraft has not been established even theoretically, let alone realized.

Millions of men have been taught to feel at home in the air, to understand it and to use it. Man is beginning to understand that the air inherently is the safest means of

1/ Morrisson, Rita Mary, unpublished master's thesis, Source Unit Organization of Two Topics, the Effects of Flight on the Human Organism and Weather, and its Effects on Flying, Boston University, 1944, p. vii.

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travel.[1] It is wide, and with properly regulated traffic there is nothing to fear. The last war has created devices that will make accident possibilities remote.

No one can foretell at this point the use of the plane or what work it will be called upon to do in the future years. History shows us that nothing stands for long in the way of mechanical advancement.

It is incredible that a lone mechanical contrivance, such as the airplane, could significantly alter man's conception of the physical world in which he lives and enable to surmount nature's obstacles, the oceans, the deserts, the mountains, and the rivers, which through the years have thwarted and deflected him. It is now possible for man to satisfy his urge to move from place to place with the utmost speed and comfort. The airplane is responsible for bringing these changes almost over night.

The speed and safety achieved by planes perhaps constitute the most profound aspect of man's conquest of the air. In the early seventeenth century, sixty days were required for our Pilgrim forefathers to cross the Atlantic in sailing vessels. Just a few years ago the fastest steamship completed the same run in slightly less than five days. At this writing, an airplane speeds up that distance to ten hours, and without stops. A round the world trip was completed the day of this writing in seventy-three hours.

1/ Loc. cit.

The world has grown very small.

The necessity for educating our youth to participate in the air age has grown complex, insistent and immediate. Our youth require a thorough introduction to the scientific principles which underlie flight. These pupils must grasp the unusual political, social, and ethical issues - local, national, and international - which the air age has raised. The problems of this air age are urgent and it is necessary that the schools respond promptly and take advantage of a rare opportunity to influence, to guide, and shape this emerging era.

Approximate time allotment -- 30 periods of 30 minutes length.

Itemized statement, or delimitation, of the unit.

1. For centuries man watched the birds, the bats, and the insects as they gracefully travelled through the air, and wished he could fly. Man made a careful study of the natural flight of both animals and seed parts of plants.
2. There are many legends of early flight trials of the ancient world that date back as far as 2000 years ago. Those ancients, gifted with prophetic vision, were unable to create a machine capable of flying because centuries were to pass before other inventions and principles necessary to man-carrying flight were discovered.

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Approximate time allotment -- 30 periods of 30 minutes length.

Learned statement, or delimitation, of the unit.

1. For centuries man watched the birds, the bats, and the insects as they gracefully travelled through the air, and wished he could fly. Men made a careful study of the natural flight of both animals and seed parts of plants.

2. There are many legends of early flight trials of the ancient world that date back as far as 2000 years ago. Those ancients, gifted with prophetic vision, were unable to create a machine capable of flying because centuries were to pass before other inventions and principles necessary to man-carrying flight were discovered.

3. Man did not make his first flight in heavier-than-air machines. It was the balloon which first lifted him off the earth. The balloon is termed a lighter-than-air craft.
4. Kites have been used for pleasure or religious ceremony by the early Asiatic peoples. The glider was next in the experimenting with heavier-than-air flight.
5. Many famous people laid the groundwork and pioneered the way to the first successful airplane.
6. The airplane is constructed according to scientific principles.
   a A wing will lift under two conditions. It may be still, as in a wind tunnel, with the wind blowing over and under it, or the wing may be pulled through the air, as is done in actual flight.
   b The wing of the airplane is lifted by air pressure, but an airplane must keep moving to stay up at all. By pointing the nose down the pilot may coast or glide safely to earth.
   c The more a wing is tilted upward against the wind, the more it lifts -- up to a certain point. If the wing is tilted too far, the wing stops lifting, and down comes the airplane. This is stalling a plane.

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7. A gasoline engine has one or more cylinders, each of which is shaped like a tomato can, closed at one end and open at the other. Fitted into the open end of each cylinder is a movable, tight-fitting plug called a piston, which slides back and forth inside the cylinder. The piston is connected by a connecting rod to a crank in such a way that if the crank is turned it pushes and pulls the piston in and out of the cylinder, or if the piston is pushed, it will turn the crank.

   At the closed end of each cylinder are two holes which may be opened or closed by valves. One of these holes is for an explosive mixture of air and gasoline to come in; the other is for the exhaust or burned gas to go out.[1/]

8. It is the turning propeller which pulls the plane along the ground and through the air. An airplane propeller resembles an electric fan.

   a A propeller is shaped a great deal like the wing of a plane.

   b The air which the propeller blows backward does not help the plane to fly. Just as the propeller, turned by the engine, can push air, so air can push a propeller.

   The push of air is what makes a windmill work.

1/ Charles K. Arey, Aviation Science for Boys and Girls, The macmillan Company, New York, 1944. p. 91, 93.

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9. The fuselage is the body of the airplane. It may have a cockpit or cabin for the occupants. It may also hold cargo.

10. The controls of an airplane. Three movements which an airplane may have are called by names derived from sailor's terms for the same movements of a ship. Yaw is the name for turning to the pilot's right or left; pitch means pointing the airplane up or down; and roll refers to tilting the plane to the pilot's right or left. These directions must be stated from the pilot's point of view.

a Stabilizers. At the end of the plane's tail are two flat pieces, like little wings, one on each of the tail. The stabilizers keep the plane flying level. They control the stability, or steadiness, of the plane in its pitching, or up-and-down movement.

b The fin. A good plane should not yaw to the left or to the right against the pilot's wishes. There is at the tail of the plane an upright piece, pointing up and down. The purpose of the fin is to control the steadiness of the plane in its yawing, or right-to-left movement.

c The elevators. Just back of the stabilizers are hinged parts which the pilot may tilt up or down. These are called elevators. When the pilot wishes to dive, he tilts the elevators

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c The elevators. Just back of the stabilizers are hinged parts which the pilot may tilt up or down. These are called elevators. When the pilot wishes to dive, he tilts the elevators

down. To climb, the pilot tilts the elevators up. With the elevators the pilot controls the pitch of the plane.

d The rudder. This is the movable upright piece just back of the fin. If the pilot wishes to turn to the right, he moves the rudder to the right. If the pilot wishes to turn to the left, he moves the rudder to the left. It is used to control the yawing movement of the plane.

e The ailerons. Rolling is the only motion of an airplane which is not controlled by the tail. To cause a plane to roll, a small flap is cut out of the rear of each wing. These flaps are arranged so that they may be tilted up and down. They are connected together so that when one tilts up the other tilts down.

11. The rudder is connected by strong wire cables, to a bar on which the pilot rests his feet. When he pushes with his right foot, the rudder turns to the right -- this makes the plane turn to the right. This principle works the same inversely. Many planes have two large pedals for the pilot's feet instead of the bar. The elevators and ailerons are connected to a lever in the pilot's hand, called a "Joyce-stick" or simply "stick". Pulling back on the stick raises the elevators and causes the nose of the plane to come up;

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pushing on the stick lowers the elevators and causes the nose to go down. Many planes have a "wheel" instead of a stick -- the principle is the same with the wheel as with the stick.

12. An airplane needs a great many more instruments than an automobile if the pilot is to fly safely in all kinds of weather.

a The air speed indicator is called the tachometer.

b The altimeter tells how high the airplane is above the ground.

c The compass tells the pilot which way he is going.

d The turn-and-bank indicator tells whether or not the plane is turning, whether or not the plane is rolled, and whether or not it is rolled enough.

e The oil pressure gauge tells the pilot whether his oil pump is working right.

f The oil temperature gauge tells how hot the engine is running.

g The fuel gauge indicates how much gasoline is in the tank.

13. When we speak of weather, we are speaking of the condition of the atmosphere. There are seven kinds of atmospheric conditions which make weather. These are:

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1. temperature
2. atmospheric pressure
3. humidity
4. wind
5. sunshine
6. clouds
7. rain, snow, hail, or sleet.

a The Weather Bureau of the United States has stations at many places over the country that help to tell where the different kinds of air and the various fronts may be and what they are doing. The Weather Bureau reports on the following things:

1. the barometer reading
2. how hot or cold it is
3. the direction of the wind
4. how fast the wind is blowing
5. how much moisture is in the air
6. how cloudy the sky is, what kind of clouds
7. how much rain (or snow) has fallen during the past day

14. Navigation is the art of flying an airplane from place to place, usually with the aid of a map or chart. In many planes, the pilot or pilots do the work of the navigation. In very large planes, such as the Clippers, Flying Fortresses,

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Liberators, and others, there is another crew member whose main duty is navigation.

a Piloting is the simplest form of navigation. It consists of flying an airplane from one place to another by watching for known landmarks on the earth below. Such landmarks include mountains, rivers, railroads, roads, race tracks, and buildings that can be clearly seen from the air.

b Dead reckoning is the most generally useful of all methods of navigation. It is a way of finding out where a plane is by knowing the path followed over the ground by the plane and the speed of the plane. The wind affects both the plane's speed and path, therefore in dead reckoning you must take the wind into account.

1. The compass does not point directly toward the North Star or toward the North Pole of the earth; it points toward the magnetic pole. This is called variation of the compass.

2. A gyroscope is simply a small wheel with a heavy rim which is spinning very rapidly. A striking peculiarity of such a wheel is that it will tend to keep itself rigidly in the same direction in space, resisting

liberators, and others, there is another crew member whose main duty is navigation.

a. Pilotage is the simplest form of navigation. It consists of flying an airplane from one place to another by watching for known landmarks on the earth below. Such landmarks include mountains, rivers, railroads, roads, race tracks, and buildings that can be clearly seen from the air.

b. Dead reckoning is the most generally useful of all methods of navigation. It is a way of finding out where a plane is by knowing the path followed over the ground by the plane and the speed of the plane. The wind affects both the plane's speed and path. Therefore in dead reckoning you must take the wind into account.

1. The compass does not point directly toward the North star or toward the north Pole of the earth; it points toward the magnetic pole. This is called variation of the compass.

2. A gyroscope is simply a small wheel with a heavy rim which is spinning very rapidly. A striking peculiarity of such a wheel is that it will tend to keep itself rigidly in the same direction in space, resisting

all efforts to change it.[1/]

c Radio navigation is recognized as the best form of navigation. Radar, which is the latest addition to flying, is fast becoming an aid to navigation. It is used by many large commercial airlines today.

d Celestial navigation is the most accurate method of all long flights. This is navigation by the stars, which are considered as not changing.

15. A map is only a kind of drawing or picture of the earth or of some part of the earth. Since the earth is shaped like a ball, it is not possible to picture it correctly on anything but a ball. The only map which is correct in every way is a globe.

a History of map making is based on man's knowledge and use of the earth.

b The airplane has abolished a world of hemispheres. It has created a monospheric world.

c Men in aviation need a knowledge of the following maps; cylinder maps, Mercator maps, Lambert's map, Polar projection maps, and know how to trace great-circle routes to find the shortest route between any two places.

1/ Charles K. Arey, Air-Age Education Series, Elementary School Science for the Air Age. New York, The Macmillan Company, 1942. p. 73.

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[1] Charles K. Arey. Air-Age Education Series, Elementary School Science for the Air Age. New York, The Macmillan Company, 1942. p. 73.

16. Aviation is now a vital link in the transportation system of the world. Perhaps the most important reason for knowing something about aviation is that airplanes have made all the world "neighbors". The large transport planes will probably be bigger, and faster, and better than those of today. They will carry more people and cargo to far-away places than any of us dream of -- and the boys and girls of today will be the ones to help them do so.

17. There are many advantages of air-travel. Aviation has shortened time and distance.

18. The most interesting place in the world to boys and girls of the air-age is the modern airport. Here is where the great planes roar into the sky for all parts of the world, and here is where they land again. This is the place where flights are planned and where planes are kept and cared for.

    a An airport must have runways. These may be made of asphalt, concrete, or grass. They must be hard enough to hold a plane.

    b The hangars are like garages for the planes. Here the airplanes are inspected, checked, and repaired. There are many men on the ground to keep an airplane in flight.

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c An airport should have lights such as a beacon, landing lights, course lights, floodlights, boundary lights, and approach lights.

19. There are state and federal laws to govern the flight of all airplanes. The Civil Aeronautics Board (CAA) plays an important role in aviation safety.

20. There are many different types of aircraft. There is an airplane for practically every purpose in peace and war.

21. Wars have had a great deal of influence on the airplane.

22. The men who service and fly our planes must be highly trained and skilled. The modern airplane represents the combined efforts of such groups as scientists, engineers, designers, and machine shop workers.

23. Aviation places rigid health requirements on the men who fly the planes.

a Physical conditions of the atmosphere affect man in flight. The atmosphere comprises at least three definite spheres or level; namely, the troposphere, the stratosphere, and ionosphere. In these spheres aviators have many health problems.

b The temperature of the air near the surface of

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b. The temperature of the air near the surface of

the earth varies. The air tends to become colder at the rate of about one degree for each 280 feet of increase in altitude until the stratosphere is reached.[1/] The fact that the temperature decreases with the ascent creates a specific problem for the airman.

c As the airplane climbs higher the air becomes progressively thinner. Pressure decreases with altitude. As a result each layer of the atmosphere is weighed down by the layer above causing the air at the lower levels to be more dense because of the pressure. The normal pressure of 14.7 pounds per square inch is sometimes called one atmosphere.[2/] The same pressure exists inside as well as outside all organisms that live at sea-level conditions.

d At high altitude, less oxygen passes into the blood and the tissues of the body soon suffer from oxygen lack, commonly referred to as altitude sickness or "anoxia".

1. The evidence of oxygen lack usually appears at about 5000 feet. At about 15,000 feet there is likely to be signs of

1/ Air age Education Series, Science of Pre-Flight Aeronautics for High School, Aviation Educational Research Groups, Teachers College, Columbia University, The Macmillan Company New York, 1942, p. 69.

2/ F. L. Fitzpatrick and Karl A. Stiles, The Biology of Flight, The Macmillan Company, New York, 1942, p. 39.

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breakdown, both physically and mentally. Sight, hearing, and muscular co-ordination begin to fail.

e Anoxia or altitude sickness can be prevented by flying below the heights at which the sickness develops. If high altitude is necessary, oxygen should be provided in either of two ways:

1. Use of oxygen tanks: Oxygen is inhaled through a rubber tube held in the mouth, supplied from a tank.
2. Use of pressure cabins: The normal oxygen content of the air and its normal pressure may be maintained. The oxygen content is maintained constant with pumps. The pressure cabin bids fair to be the ultimate solution of the problem of high altitude flight.

f In flying at high altitude one obvious problem is to prevent heat dissipation from the skin. The need is all the more acute because the flier cannot make up heat loss by physical effort. Suitable clothing is the most practical way to reduce heat loss from the flier's body. To surround the body with a motionless layer of air would be the best way to prevent heat conduction but this is not possible.

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g "Seasickness" or nausea sometimes come to the novices when the air is turbulent.

h "Black-out" is the effect of positive acceleration, due to the fact that the forces acting from head to feet prevents the blood being pumped by the heart to the head in normal amounts, so there is relative lack of blood and a drop in blood pressure above the area of the heart.

i Various methods are used for preventing "black-out".

1. Taping the legs and abdomen.
2. Yelling when pulling out of a dive.
3. Wearing a broad tightly buckled belt.
4. Wearing an inflatable belt.
5. Wearing a water suit such as is worn by German aviators.
6. Sitting in a position known as the "forward crouch".
7. Tensing the muscles of the legs and abdomen.
8. Elevating the legs.

j <u>Airsickness</u> is a condition due largely to rotary motions and vertical accelerations in aircraft flight and has no reference to altitude sickness or oxygen lack. It is characterized by nausea, vomiting, instinctive fear, vertigo, perspiration, and prostration which occur principally

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j Airsickness is a condition due largely to rotary motions and vertical accelerations in aircraft flight and has no reference to altitude sickness or oxygen lack. It is characterized by nausea, vomiting, instinctive fear, vertigo, perspiration, and prostration which occur principally

as a result of acceleration, chiefly vertical, in aircraft flight. Since it is a combination of equilibratory changes and psychologic-apprehension, airsickness may be considered a true functional neurosis.[1/]

k Many tragedies of the air are caused by difficulties for which the organs of balance are responsible. The principal organs of orientation and balance are the eyes, ears, and various parts of the muscular and skeletal systems.

24. The growing importance of aviation in the modern world tends to focus interests and attention upon the selection of superior pilots. One of the requisites, of course, is physical fitness for this particular type of activity. To a large extent physical fitness depends upon the efficiency of the sense organs.

25. The following qualities of physical fitness for pilots require consideration:

a Acuity of vision -- sharpness of vision.

b Accomodation of vision -- the human eye is focused by changing the shape of its lens.

c Color vision -- one of the vision defects that cannot be corrected.

1/ Lieutenant Howard R. Bierman, "Nutrition in Aviation Medicine", War Medicine, January 1943, p. 13.

d Depth perception -- ability to judge relative distance accurately.

e Co-ordination of the eyes -- referred to as ocular muscle balance.

f Hearing -- ability to hear whispered numbers from 20 feet distance.

g Balance or equilibrium -- known by the "feel of things" whether one is banking and turning in a controlled manner.

h Muscular co-ordination.

i Tremor -- steady hand.

j Muscular strength -- test of strength.

k Blood pressure -- 150 mm systolic pressure.

l Teeth -- correction to be taken care of.

26. The airplane industry provides a means of earning a living for many people.

a There are many opportunities for jobs and careers in the aviation industry.

b Those associated with the airplane industry need high skilled training.

27. Aviation has a great future.

Probable indirect and incidental learning products.

1. A knowledge of the significant changes in world affairs which have been brought about by aircraft.

2. An attitude of due respect toward the aviation pioneers.

3. An attitude of cooperation with individual and group.
4. An attitude of acceptance of responsibility while working on activities, individually or as head of a group.
5. An attitude of respect for the suggestions and opinions of others.
6. An interest in the further study of aviation.
7. Facility in the use of the unit assignment.

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Aeronautical books will be loaned without charge to any member of this Institute of the Aeronautical Sciences who agrees to adhere to the rules of the Library. As far as the facilities permit, any person in the United States over 18 years of age, who can furnish references which certify to his or her responsibility, may become a member of the Library.

The Unit Assignment

Introduction.-- 1. Show the following film to the class;

Airplane Changes the Map of the World, Encyclopedia Britannica Films.[1/]

Following the showing of the film a short discussion was held on the following highlights:

a. How has the airplane changed the map of the world?

b. What is a great circle route?

c. Describe the Mercator projection?

d. What is meant by dimensions? How many dimensions are there on flat maps?

e. Are flat maps accurate?

f. Give reasons why you think maps are important to pilots and aviation?

2. Describe a flight made in an airliner from Boston

1/ This film obtainable at the Boston University, Visual Aids Library.

to Washington, D. C. With the aid of a map show the route taken. Compare the route taken by automobiles and the time required for the trip. Make a description of the differences between the appearance of geographical features as viewed from an airplane, and as viewed from the automobile. An explanation of how it feels to be flying in an airplane would be given.

3. The writer's own personal experiences as a former Naval Aviation Cadet were used during the approach along with the suggestions of commercial flying used in item two.

At the close of the period, the children were asked to bring in pictures, books, maps, models, or anything else they might have at home dealing with aviation. The first part of the second period the pupils who brought materials were asked to show and describe the articles to the class. The pupils' materials were supplemented by the teacher's collection of pictures, clippings, and a large airplane model. During the discussion that resulted from this activity, the pupils were guided in their plans to gain further information on the subject of aviation.

Individual and small-group work. The following mimeographed study-and-activity guide was handed out to the pupils at the close of the introductory activities.

Read this study-and-activity guide carefully. Check (✓) the items which interest you most. Can you think of any

other really interesting things which might be done in connection with the unit? If so be sure to let your teacher know. If at any time later you should think of any interesting activity, not listed below consult your teacher about the possibility of using it in this unit. You are to keep a notebook for this unit.

1. How long ago did man think of flying and what made him want to fly? There were many trial flights and inventions in the field of flying before the airplane became too important. Can you imagine how the first man that attempted to fly did it? Did he get his idea from a bird, a flying leaf, a kite, or just where did he get it? Who were Daedalus and Icarus? (5:11-14) (5:27-29) (3:19) (15:439)
2. What was Leonardo da Vinci's contribution to flying? Where did he get his ideas of flight? Tell the story of his toy helicopter. (26:31) (4:63) (5:50-52)
3. How did seeds give man ideas about flying? What part of the seed acts as a parachute? Name the words that go to make up "parachute". (5:37-42)
4. What race of people invented the kite? What are kites used for? Tell why a person holding a kite runs behind for a short distance and throws the kite into the air. What kinds of kites are there? Why do kites fly? (5:43-46) (3:24-26) (8:130-131) (1:53-55)

5. The first man who went into the air used a balloon. Why do balloons rise? Why is a balloon in the air like a piece of wood in water? Explain reasons why a balloon will rise? What gases are commonly used in balloons? (1:58;72) (5:47) (26:31)
6. Describe the experiments of the Montgolfier brothers. Tell when and where these experiments were made? What was their balloon filled with? Who were the first passengers? How long did the first balloon trip last? Describe other early balloon flights. (10:129-130) (5:48-49) (1:59-61) (15:442-443) (27:5-9) (26:23-25) (8:135-139) (4:63-68) (3:26-29)
7. What are the uses of the balloon and dirigible? (1:61-72) (3:29-30)
8. Demonstration: Some things float; others sink. Pupil leader prepare materials and show that some float and others sink. Get an aquarium or tank and fill it with water. Try floating the following solid materials; a wood cork, an empty stoppered bottle, stones, a sponge, etc. What do you notice about the objects that feel light for their size? What happens to the heavier objects? Will iron objects float? Try floating an empty tin can in the tank. Does it float? Take the same metal can and smash it flat, although its weight has

not been changed, its volume or size has. Does it sink when flattened out? If we increase the weight of an object and not alter the volume or size will it float? Take a floating tin can and put sand or water into it, thus increasing the weight. What happens to the weighed can?

9. Demonstration: A floating object pushes aside its own weight of water. Pupil leader prepares materials and performs the demonstration. Get a spill can and a sensitive scale. First weigh very carefully a clean dry water tumbler. Fill the spill can very carefully until water starts to run out the spout. (see Figure 10) Let the water stop running. Carefully weigh a block of wood of a size which will fit in the spill can. Place the weighed tumbler under the spout of the can to catch any water which may run out. Gently lower the weighed block into the can of water until it is floating freely, meanwhile catching all the water which is forced out the spout. Allow the water to stop flowing, and then weigh the tumbler with the water it contains. Subtract the original weight of the tumbler to get the weight of the water which was forced out of the can. Is the weight of the water about equal to the weight of the wooden block? What does this tell us about floating

objects? Why does the wood block rise again if it is pushed under the water? Do balloons push aside more than their own weight of air? Does this tend to make balloons rise until the weight of air pushed aside equals the weight of the balloon?

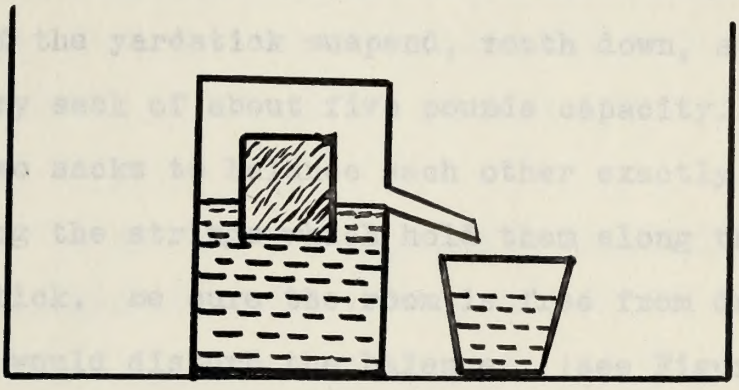
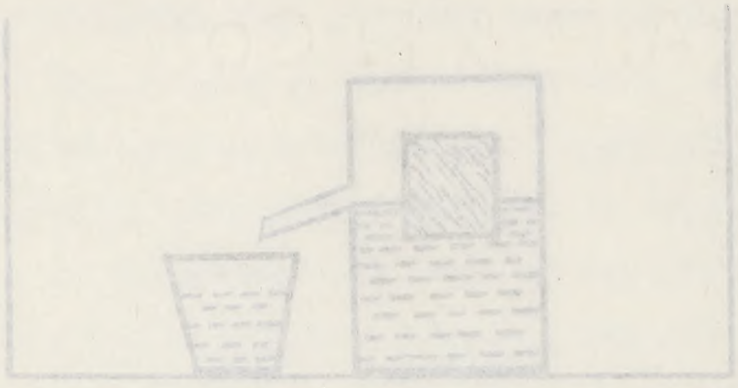


Figure 10. Measuring the water displaced by a block of wood.

10. Demonstration: Pupil leader perform the following experiment. Partly inflate a small balloon and try to push it under water. Use an aquarium two-thirds full of water and a toy balloon for the experiment. What principle previously shown does this experiment show us?

11. Demonstration: Air expands when it is heated. Pupil leader prepares materials and performs the following experiment. Fit a small rubber balloon over the mouth of a Pyrex nursing bottle. Heat the bottle with a flame (use alcohol burner). What happens to the balloon as the air in the bottle becomes heated? What does this show us about air



when it is heated?

12. Is heated air pushed up by cooler air?

Demonstration: Pupil leader prepares materials and performs following experiment. Suspend a yardstick from a string tied around its middle. From each end of the yardstick suspend, mouth down, a paper grocery sack of about five pounds capacity. Get the two sacks to balance each other exactly by sliding the strings which hold them along the yardstick. Be sure the room is free from drafts which would disturb the balance. (see Figure 11)

When the sacks are balanced, hold a lighted candle under one to heat the air in it. What happens to the heated sack? What does this show about the heated air?

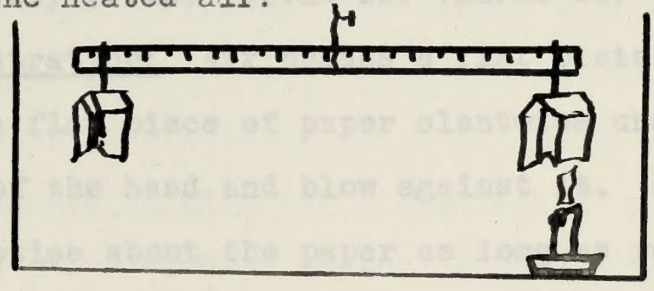


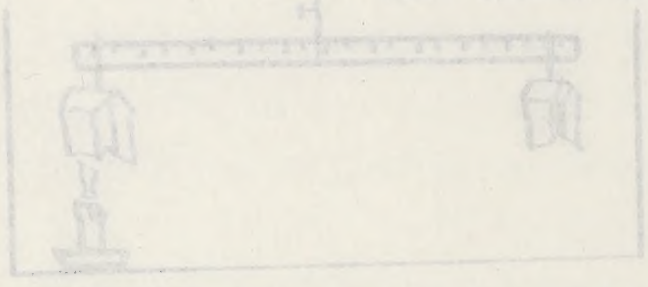
Figure 11. Heated air is pushed up by cooler air.

Teacher shows sound films "Balloons" and "Airships" 1/ and gives pupils following questions about the films:

a How many centuries has man been able to fly?

b Describe early successful and unsuccessful balloon flights?

1/ Good Year Motion Pictures, Akron, Ohio. 400 foot, 15 min. sound reels on dirigibles and lighter-than-air travel.



c What gases can be used to inflate balloons? Which gas is most commonly used? Why?

d Tell why "sandbags" were used?

e What did the word "dirigible" get its name from?

f Name the present uses of balloons and dirigibles?

13. Why are balloons and dirigibles called "lighter-than-air"? (3:39) (5:47) (8:134) (27:3) (1:58) (7:274-279)

14. What will happen to a <u>flat plate inclined forward at an angle</u> if wind is blown against it? Why does the flat plate move upward? Is this principle used in kite-flying? What four forces act on a flying kite? Is there any resemblance with this flat plate and an airplane wing? (3:41;25) (1:79-80) (5:45) (28:12-13) (11:23-30) (20:10)

15. <u>Demonstration:</u> Air pushes a flat plate upward. Hold a flat piece of paper slantwise under the palm of the hand and blow against it. What do you notice about the paper as long as your breath continues to strike it? What happens when you stop blowing against the paper? Hold the paper in a similar position and run with it. Does this have the same effect as blowing on it?

16. How can the path of air currents blowing against a flat plate be improved? What are "eddies"? What effect do "eddies" have on the flat plate? (3:41) (26:19)

17. Describe the early experiments that led to successful flying of the following aviation pioneers: (4:72-85) (1:75) (15:444-449) (5:55-66) (8:131) (22:85)

    a John J. Montgomery

    b Otto Lilienthal

    c Octave Chanute

    d Wright Brothers

    e Samuel P. Langley

    f Sir Hiram Maxim

18. What makes a wing lift? What is the shape of most airplane wings? Explain reason for having the front edge of a wing thick and the rear edge thin. Is this a "streamline"? What is meant by drag? What causes a "vacuum" above the wing? (1:76-81) (8:132-133) (3:42-44) (28:15-17) (15:449) (4:87-88) (5:67-71)

19. Experiments to show why a wing lifts:

    a Get two ping-pong balls. Fasten a string about eight inches long to each of them, using a little glue or a piece of gummed paper. Hang the balls from a pencil, so that they hang about one-half inch apart. Blow a stream of air between the balls with a straw. A large straw is better to use. Why are the balls pulled together? Is there any connection with

17. Describe the early experiments that led to successful flying of the following aviation pioneers:
(4:72-83) (1:75) (15:444-449) (3:33-66) (6:181) (22:85)

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b Otto Lilienthal

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d Wright Brothers

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f Sir Hiram Maxim

18. What makes a wing lift? What is the shape of most airplane wings? Explain reason for having the front edge of a wing thick and the rear edge thin. Is this a "streamline"? What is meant by drag? What causes a "vacuum" above the wings? (1:78-81) (8:188-189) (3:[illegible]) (20:15-17) (15:449) (4:87-90) (3:87-91)

19. Experiments to show how a wing lifts:

a Get two ping-pong balls. Fasten a string about eight inches long to each of them, using a little glue or a piece of gummed paper. Hang the balls from a pencil, so that they hang about one-half inch apart. Blow a stream of air between the balls with a straw. A large straw is better to use. Why are the balls pulled together? Is there any connection with

air pressure? (1:82)

b Hang two teaspoons back to back and a little way apart. You will probably need to use an arrangement of two pencils and two strings to hold each spoon steady. Blow air between the spoons with a straw. Do the spoons come together? Was the air pressure between the spoons lessened by blowing between them? (1:83)

c Cut two squares of typewriter paper about six inches on a side. Glue or paste opposite edges of each square together. You now have two light paper tubes. Lay two long pencils side by side on the table so as to form a pair of rails on which the paper tubes can roll. Lay the tubes on the pencils, side by side and about an inch apart. Blow between them. Are the tubes blown together or are they blown apart? (1:84-85)

20. What is meant by "stalling a plane"? Is it the same as stalling an automobile? What is the result if a pilot "stalls" one wing while the other wing is still "lifting"? How far can an airplane glide if it is one mile high? (1:87-88) (4:89-91)

21. We have discovered that an airplane's wing must be in motion in order to stay aloft, therefore must have an "<u>engine</u>". What are the main parts

of a gasoline engine? What does each part look like? How is each part related to the other? (1:91-97) (3:66-70) (7:421) (16:310-315) (15:449) (28:164-189) (4:177-191)

22. How is an airplane propeller different from a windmill? Is there any resemblance in a propeller and a wing? Where is the low pressure found when a propeller is in motion? Where is the high pressure found when a propeller is in motion? What is meant by "feathering" a propeller? Why is this done? Give a reason why propellers are usually made of about two or three blades? (1:98;100) (29:375) (31:219-233)

23. Demonstration: Compare a home-made pin-wheel type propeller (1:101) with a rubber-band-powered propeller on a model airplane.

24. Of what use is the fuselage? What names are given to the section where the pilot, passengers sit? What is the shape of most fuselages? Is there another purpose for the fuselage? (10:133) (30) (15:450)

25. Is an airplane steered in the same way as an automobile? Is the airplane steered in a similar way as a boat? In how many different ways is an airplane steered? What is the turning motion to the left or right called? What is the movement of the nose up or down called? What is the tilting

to left or right called? (1:106-110) (7:393-396) (28:19-21) (4:92-94) (12:319)

26. Where are the stabilizers located on an airplane? What is there purpose? Do they help the plane to fly level? (1:111) (7:396-397)

27. What is the purpose of the airplane's fin? Where is it located? (1:112) (26:168) (7:396-397)

28. What parts of the airplane help the pilot "dive" or "climb"? (1:113-114) (7:396-397)

29. What part of the airplane helps the pilot to turn to the right or left? How can you tell this section from the fin? (1:114) (7:396-397)

30. What are the ailerons? Where are they located? When one aileron goes up the other goes down, can you tell the reason for this? (1:114-115) (26:147-157)

31. Demonstration: With the use of a model airplane having moveable parts explain how each part affects flight. Make a diagram on a large oak tagboard or on the blackboard showing how each part is connected and how the pilot controls the plane. Make sure to demonstrate the use of the "stick" and the "pedals". (31:24)

32. Why does an airplane need many more instruments for its operation than the automobile does? Describe what each of the following instruments

to left or right ceiling (1:156-170) (7:393-396)
(28:19-21) (4:93-94) (12:319)

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What is there purpose? Do they help the plane to
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Make sure to demonstrate the use of the "stick"
and the "pedals". (31:24)

32. Why does an airplane need many more instruments
for its operation than the automobile does?
Describe what each of the following instruments

is used for: (4:193-206)

a tachometer (1:134-136) (28:100)

b altimeter (1:136-138)

c compass (1:138-140) (21:211-224) (33:81-87)

d turn-and-bank indicator (1:140-141)(28:145)

e oil pressure gauge (1:132)

f oil temperature gauge (1:132-134) (28:100)

g fuel gauge (28:100)

33. Demonstration: The gyroscope -- a part of many airplane instruments. Procure a toy gyroscope and perform the experiments shown in reference (3:74)

34. Why is weather one of the most important things to a pilot? When we speak of "what weather is" are we speaking of the condition of the atmosphere? How many kinds of atmospheric conditions make up weather? (1:144-147) (32:99) (21:184-196)

35. Write a short paragraph, for your notebook, explaining each of the following kinds of atmospheric conditions: (1:147-154) (21:187-196) (9:54-56)

a temperature

b atmospheric pressure

c humidity

d wind

e sunshine

f clouds

g rain, snow, hail, or sleet

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36. Explain why it is necessary for aviators to know what the weather will be? What are some of the weather signs? What is the work of the Weather Bureau? (35:101-121) (21:198-206) (9:43-53;56-72) (1:160) (36:49-78)

37. What are some of the weather superstitions? (9:58-59)

38. What do the terms "ceiling" and "visibility" mean in aviation language? Is the word "CAVU" a good report for a pilot to hear? (1:144)

39. Name some of the ways a pilot can judge the speed of the wind? Use the Beaufort table (21:206) This list is to be kept in your notebook.

40. Study the weather map carefully (21:200). How can you tell from this map that Minneapolis will probably have cooler, clear weather in a day or two? Bring to school a weather map from your daily newspaper and predict the weather for the next few days. (32:101-109) (16:109-114)

41. What is navigation? Who does the navigating in most plane? What type of planes employ a person whose main duty is "navigating"? What are the advantages of having a full time navigator in an airplane? (1:171) (3:116)

42. What is the simplest form of navigation? Name the aids used in this form of navigation? What are the advantages and disadvantages in the

36. Explain why it is necessary for aviators to know what the weather will be? What are some of the weather signs? What is the work of the Weather Bureau? (35:101-121) (21:196-206) (9:48-52;56-72) (1:160) (36:49-78)

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41. What is navigation? Who does the navigating in most planes? What type of planes employ a person whose main duty is "navigating"? What are the advantages of having a full time navigator in an airplane? (1:171) (3:118)

42. What is the simplest form of navigation? Name the aids used in this form of navigation? What are the advantages and disadvantages in the

"piloting" type of navigation? (1:172-173)

43. Give reasons why "dead reckoning" is the most useful of all methods of navigation? Why must the wind be taken into account in dead reckoning? What instrument is necessary in dead reckoning? What is meant by variation of the compass? (1:173-180) (18:139-154) (29:300-307) (33:85-88) (12:278-287)

44. What is meant by "flying on the beam"? Explain how radio is an aid to navigation. What is the greatest advantage of radio navigation? What ground instruments are necessary for radio navigation? (1:185-197) (4:291-303) (28:220-232) (36:172-198)

45. What is radar doing for the aviator? Write to a commercial airline company asking the use they are making of radar.

46. Demonstration: How the airplane's loop aerial functions. With the aid of a portable radio perform the following demonstration. Turn on the radio, tune in a station, and lower the volume control until the station comes in very softly. Pick up the set and turn it slowly around. You will probably find two places where the broadcasting station cannot be heard, and two places where it comes in quite loud. This happens because most portable radios have loop aerials.

Repeat the experiment several times, using different broadcasting stations. Where is the loop found on airplanes? In which two ways may the loop be used? Is the loop a direction finder? (1:192-195)

47. Why is celestial navigation the most accurate for long flights? How can pilots tell their position by the "stars"? Explain how the "sextant" is used. How are maps used in this type of navigation? (1:180-182) (37:217-218;320;323-354) (18:113-122) (6:5-26)

48. How do we locate places on the earth? Explain on a globe meridian lines -- longitude and latitude. How has the airplane created a new world of geography? (1:199-202) (2:1-6) (5:75-82)

49. Men in aviation need a knowledge of the following maps, write a descriptive paragraph about each type for your notebook:

    a cylinder maps (1:203-205) (2:12-15)

    b Mercator map (1:205-207)

    c Lambert's map (1:207-209)

    d Polar projection maps (1:209-211) (2:41-44)

50. What is the easiest way to find the shortest route between any two places on a globe such as the earth? What is a great-circle? Are parallels great-circles?

51. Demonstration: The importance of great-circle routes. On the school globe stretch strings from the place where you live to a number of important cities, such as Moscow, London, Berlin, Tokyo, Paris, Lisbon, New York, and Liverpool. Notice the routes taken by the strings. Notice also that, since many of the world's important cities are in the northern hemisphere, many of the strings pass over Alaska, the Arctic Ocean, or Greenland.

Look at the Mercator map and the polar map on pages 206 and 210 of reference 1. Look at the lines drawn between Tokyo and the Panama Canal, between New York and Moscow, and between New York and Rio de Janeiro on the Mercator map. Those look like the shortest distances to those cities. What places would a plane pass over if it flew the routes marked on a Mercator map?

Now look at the lines drawn between these same places on the polar map. Are you surprised to see that a plane taking the shortest distance from Japan to the Panama Canal would fly over Alaska, Denver, and the Gulf of Mexico? The lines drawn are not quite straight, because they show the great-circle routes between the cities which have been mentioned. Compare these shortest-distance routes with the routes on the Mercator map. Over what places would a plane fly on the shortest

61. Demonstration: The importance of <u>great-circle routes</u>. On the school globe stretch strings from the place where you live to a number of important cities, such as Moscow, London, Berlin, Tokyo, Paris, Lisbon, New York, and Liverpool. Notice the routes taken by the strings. Notice also that since many of the world's important cities are in the northern hemisphere, many of the strings pass over Alaska, the Arctic Ocean, or Greenland.

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route between any of the pairs of cities mentioned?

Suppose you were the person in charge of one of the great airlines. Your airliners would be carrying people and goods between all the chief cities of the world. Which kind of map would you use to plan the routes for your airliners?

52. Aviation is now a vital link in the transportation system of the world. How has the airplane made all the world "neighbors"? What are the advantages of air-travel? (38)

53. Field trip. Teacher conducts class to the Bedford, Mass. airport.[1/] The pupils will better enjoy the trip if they become acquainted with the following: (5:91-95) (7:381-404) (1:2-28)

a flight planning

b runways - landing rules

c hangars - plane maintenance

d lights - beacons

e passengers and cargo

54. Men who fly need to be healthy. Why does high altitude affect breathing? What is the pressure of air at sea-level? What happens to the air as one goes up into the higher regions of the atmosphere? What happens to the body when one suffers from lack of oxygen? What is "anoxia"? What visible

1/ Pupils are issued a special study-and-activity guide to cover this excursion. See appendix.

signs tell us when a pilot has anoxia? How can anoxia be prevented? (23:167-171) (8:140-141) (36:319-320)

55. The temperature of the air becomes cooler as one goes high into the air--until the stratosphere is reached. What kind of clothing does the pilot need? (32:527-531) (35:77-80) (16:388-391)

56. What are some of the common ailments that confront the pilots? How does the novice flyer feel when the air is rough? What causes black-out? How may black-out be prevented? (Encyclopedia)

57. Why does the aviator need perfect eyesight? What are some of the eye defects that would keep a person out of flying? (36:321-326)

58. What are sense organ aids in the orientation of a pilot? How does hearing aid the pilot?

59. How have women helped the aviation progress? Make a list of famous women flyers and give their achievements. (4:222-238)

60. What is the future of aviation? What opportunities are there for the future young flyers of America? (4:239-272; 315-327) (36:200-242) (15:454-456) (29:377) (5:133-135) (3:95-100)

Optional related activities.

1. Develop a timeline showing how close other,
   a cities are from Boston
   b lands are by use of the airplane.

Optional related activities.

1. Develop a timeline showing how close other
   a cities are from Boston
   b lands are by use of the airplane.

You may do this in graphic or map form.

2. Make a booklet on aviation vocabulary. Wherever possible illustrate the air-expressions. (4:304-314)
3. Serve on a committee of three and keep the class bulletin board up-to-date on aviation material. Include current news items and clippings from such newspapers and magazines as the Boston Traveler and Collier's, etc.
4. Make a collection of air-mail postage stamps. Mount them suitably for display to the class.
5. Keep a careful record of the weather for two weeks. In your record include: visibility, cloud formations, wind speed and direction, and temperature. Tell whether or not the day is suitable for flying.
6. Sketch, then paint, a large wall mural showing some important phase of aviation. This may be of the history of aviation, the airplane in warfare, or the airplane in peacetime, etc. One pupil is to act as chairman for this mural. He is to choose three other classmates to aid him.
7. Make a scrapbook of the different types of airplanes from early times to the present. Some of these may be actual snapshots taken by you. Each one is to be mounted and labeled clearly.
8. Read, then give an oral report on, any of the books in our school library.

5. Make a booklet on aviation vocabulary. Wherever possible illustrate the air-expressions. (4:304-314)

3. Serve on a committee of three and keep the class bulletin board up-to-date on aviation material. Include current news items and clippings from such newspapers and magazines as the Boston Traveler and Collier's, etc.

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7. Make a scrapbook of the different types of airplanes from early times to the present. Some of these may be actual snapshots taken by you. Each one is to be mounted and labeled clearly.

8. Read, then give an oral report on, any of the books in our school library.

9. Draw then paint clearly opaque slides, size 4"X6" showing a series of airplanes or balloons. These may be transport, war, peace, or training planes. You may include gliders.
10. Make a model airport for the classroom. Choose three other pupils to help you. Include in this model hangars, runways, beacons, landing markers, airplanes, etc.
11. Construct a model airplane as shown in (25:37-41) or (24) Directions and required supplies are all given in this book.
12. Construct a kite as described in (25:25-26) or (20:31-32)
13. Make a list of the ways in which the airplane is likely to effect your life from this time on. Consider food, clothing, recreation, entertainment, vocations, housing, location, health, and other general interests.
14. Investigate famous stratosphere flights and report your findings of the greatest height reached by man.
15. Give a written report or an oral report on Wiley Post's contribution to the science of aviation for high altitude flying.
16. Write a personal experience, your own or someone you know who has traveled in a plane. Describe

the sensations experienced.

17. Read the article "Curvature of the Earth" by Captain A. W. Stevens, National Geographic, May 1933. There are some excellent photographs showing division between the troposphere and the stratosphere. Show them on the projector to the class.
18. Collect poems of flight, especially those related to high flying. Read some of these poems to the class.
19. Make a poster on "flying hazards".
20. Report to the class on any articles found in current magazines that you have found interesting to read.
21. Make a list of the physical qualifications you believe to be essential for all aviators to possess.
22. Prepare an oral report on one of the important aviation pioneers or on some famous flight.
23. On a series of cards, size 6"X8", illustrate the weather instruments that are necessary to an average weather reporter. These may be shown on the projector.
24. Name and describe the instrument which uses a human hair as a measuring device.
25. Look up recent advances in methods of de-icing aircraft. Describe to the class the details of

the sensations experienced.

17. Read the article "Curvature of the Earth" by Captain A. W. Stevens, National Geographic, May 1934. There are some excellent photographs showing division between the troposphere and the stratosphere. Show them on the projector to the class.

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23. On a series of cards, size 6"x8", illustrate the weather instruments that are necessary to an average weather reporter. These may be shown on the projector.

24. Name and describe the instrument which uses a human hair as a measuring device.

25. Look up recent advances in methods of de-icing aircraft. Describe to the class the details of

how de-icing equipment works. Make a working model of a de-icing device to show to the class.

26. Find out how the radio beam operates and write a report on its use in making flying safer.

27. Place some ice cubes in a shallow pan and blow across it. Then answer the following question:

    a What occurs above the ice?

    b How does fog made in the classroom compare with fog you are apt to see on a clear summer evening?

    c Make a diagram to illustrate the ice cube experiment. Label: warm air, fog, cold surface, and type of fog.

    d Under what circumstances would fog of any kind occur?

28. Give several examples from your everyday experiences to prove that water heats and cools more slowly than the surrounding land. Explain how this principle affects aviators and flying.

29. Demonstration:

    Equipment: For this experiment you need a round-bottom flask, a beaker of water, a rubber stopper with one hole, glass tubing to fit stopper, alcohol burner, and a clamp stand.

    Procedure: Set up the apparatus. Heat the flask which is filled with air by gently moving the alcohol burner flame back and forth over the flask,

then answer the following question:

a What happens to the air in the flask?

b How does the air pressure on the surface of the water in the beaker compare to the air pressure in the flask when the experiment began?

c How does the air pressure on the inside of the flask compare with the air pressure on the surface of the water?

d Allow the air in the flask to cool and then tell what happens. Why?

e If a parcel of air in the atmosphere is heated what would happen to it?

30. Construct a series of flash-cards showing silhouette of planes. Show these to the class for their identification. Materials needed: India ink or poster paint. Procedure: Draw an outline of the plane and fill in with black ink or poster paint.

31. Make a collection of the commercial transport airlines' ensignias. Mount and label these properly for demonstration. See "Air Transportation" pamphlet, 1946.

32. Demonstration: Inertia

a Attach a spring balance to a loop of string tied around a brick. What force is needed to keep the brick in motion?

then answer the following question:

a What happens to the air in the flask?

b How does the air pressure on the surface of the water in the beaker compare to the air pressure in the flask when the experiment began?

c How does the air pressure on the inside of the flask compare with the air pressure on the surface of the water?

d Allow the air in the flask to cool and then tell what happens. Why?

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31. Make a collection of the commercial transport airlines' ensignias. Mount and label these properly for demonstration. See "Air Transportation" pamphlet, 1966.

32. Demonstration: Inertia

a Attach a spring balance to a loop of string tied around a brick. What force is needed to keep the brick in motion?

b What force is needed to keep the brick moving at a uniform speed?

c Place a cardboard about four inches square over the mouth of a bottle. Place some small coin on the cardboard directly above the mouth of the bottle. Quickly snap the card sideways off the bottle with your finger. What becomes of the object on the cardboard. Why?

d What is inertia?

33. Make a survey of the people you know, such as relatives, friends, or neighbors. Find out;

a How many are flying airplanes now.

b How many flew an airplane during the war.

c How many have been passengers in airplanes, on long trips or short hops.

d Are there any navigators, bombadiers, maintenance men, stewardesses, or airline company office workers.

Describe any experiences these people may tell you. Report your findings to the class.

34. Make a "Who's Who" of famous flyers, aviation pioneers, war heroes, women flyers, etc. Give the name and a short paragraph about each ones life.

35. Construct a slingshot glider.

Materials needed: A stick of wood one-quarter inch

square and ten inches long.

A tiny block of wood one by one-quarter by one-eighth inches.

A sheet of tagboard.

A small brad.

Five rubber bands.

A forked stick or a frame for a slingshot cut out of wood.

Directions for constructing: Cut two wings and a rudder out of tagboard. Saw a slit down the middle of the stick for three inches from one end. Slip the straight edge of the rudder into this slit and glue it in place. Glue the small block of wood to the middle of the front edge of the small wing.

Drive the brad into the lower side of the stick of wood near the front.

Fasten the large wing in place just over the rudder with a rubber band.

Fasten the small wing near the other end of the stick of wood with a rubber band. The small block of wood should rest on the stick. The wing will be on a slant.

The glider is now done. It should glide very well if you throw it small wing first. It will work better if you shoot it with the slingshot. You have to be out of doors to use the slingshot.

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Drive the brad into the lower side of the stick of wood near the front.

Fasten the large wing in place just over the rudder with a rubber band.

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The glider is now done. It should glide very well if you throw it small wing first. It will work better if you shoot it with the slingshot. You have to be out of doors to use the slingshot.

To make the slingshot, knot three thin rubber bands together. Fasten one end of the string of rubber bands to each fork of the stick or slingshot frame.

Hold the slingshot in one hand. Catch the brad underneath the glider in the middle rubber band of the slingshot. Pull the glider back. Then let it go. Sometimes the air pushing on the small, slanting wing will make the glider loop the loop. (20:28-29)

36. Give a report to the class on "Motorless Flight". Make an outline of the report. (4:207-221) (26:203-227)
37. Get a collection of pictures of different kinds of kites. Use clippings, snapshots, or drawings. Your library has a book on Chinese kite celebrations. Mount the collection suitable for display.
38. Suppose you had a balloon and could fill it with heated air, hydrogen, or helium. Which would you choose? Write a short paragraph telling reason why?
39. If possible get Life magazine of June 21, 1943, and read about how aviators use kites when they are forced down at sea. Report on the story to the class.
40. <u>Demonstration</u>: Have someone hold two pencils

To make the slingshot, knot three thin rubber bands together. Fasten one end of the string of rubber bands to each fork of the stick or slingshot frame.

Hold the slingshot in one hand. Watch the bread underneath the glider in the middle rubber band of the slingshot. Pull the glider back. Then let it go. Sometimes the air pushing on the small, slanting wing will make the glider loop the loop. (20:28-29)

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40. Demonstration: Have someone hold two pencils

upright on the table. Make a paper tube by cutting two squares of typewriter paper about six inches on a side. Glue or paste opposite edges of each square together. Lay the tube on the table, resting against the pencils. Blow as hard as you can through a soda straw so that the air passes just over the tube. What happens to the tube? If you practice a little, you can make the tube roll upward along the pencils for several inches before your breath gives out. (1:85)

41. Card and spool demonstration: Hold an ordinary thread spool upright and lay a small piece of cardboard such as a visiting card on the spool. Stick a pin through the card and into the hole in the spool. This will keep the card from sliding off. Now get someone to try to blow the card away by blowing through the hole in the spool. Why can't he blow the card away? If a person has plenty of breath he can hold the whole thing upwide down while blowing and the card will not fall off. Why is it held in place? Does an airplane wing lift because of this same principle? There is a narrow space that occurs when air is forced between the curved wing and the motionless air which is a little above the wing.

42. Suppose you were flying a small private plane to a town a hundred miles from your home on a clear

day. Write a paragraph telling what kind of navigation you would use and why?

43. Show the class by the use of a compass which direction is north, south, east, or west.

44. Find a picture of a sextant and explain to the class what it is used for on a ship or in an airplane.

45. Write a short story of a pilot who had to use dead reckoning to get back to his base or aircraft carrier. See page 175 of reference 1.

46. Demonstration: Get several oranges. On each one mark off some meridians, an equator, and some parallels. Cut one orange in two along a meridian, another in two along the equator, and a third in two along a parallel. Notice that the first two oranges are cut into equal halves, but the third is not. On the earth the Equator and all the meridians are great circles; the parallels are not. Take another orange and cut it into thin circular slices. Notice that one slice is larger than the rest. This is more or less a great circle, while the smaller slices are small circles.

47. Using reference 17 plan a trip across the country. Show pictures of the principle cities, land formations, etc. Tell the highlights of the trip you plan from this book. Explain why you chose the route you did.

48. Give a complete report on parachutes. Explain the principle involved by using a home-made model. Use the following references; (30:175-180) (26:229-262) (39:225-234) (3:10)

49. Make and demonstrate a model wind tunnel. If this is not possible you may draw a picture of one and explain it to the class. (4:247) (26:100)

50. Cartesian diver demonstration: Take a tall, wide-mouthed bottle or jar and fill it nearly full of water. Take a small bottle with enough water in it so that it will barely float in the jar. Hold the water in the small bottle by placing your finger over the top while you put the bottle bottom up in the jar. Tie a sheet of rubber (rubber from a toy balloon will do) across the mouth of the jar tightly. Now when this rubber sheet is pressed, does the bottle rise or sink? Why? When the pressure is removed from the rubber sheet, does the bottle sink or rise? Why? (7:266)

51. Prepare a "Do you Know" or "Believe it or not" list of questions carefully selected because of the interest or information value it has. For example: Make a game similar to the quiz programs on the radio. Prepare a stack of cards with questions on them and find out how well informed your class is on the subject of aviation.

52. Make a gold dust (flash-on) star map. Draw on a cardboard the general shape of any one constellation. Make small pencil dots on this drawing to represent the different stars. With a speed-ball pen dipped into bronzing liquid, make small dots over the pencil dots. With a sharp pen or needle make a small hole through each painted dot. Show several of these charts to the class by darkening a room and placing a flashlight behind the cardboard.

53. Collect a variety of stamps that have astronomical designs on them. Foreign stamps should be sought out for the seccessful completion of this exercise.

54. Compile a number of old beliefs and superstitions concerning the stars and their influence on man. Be prepared to show whether or not these beliefs are supported by scientific facts. Show how this type of thinking influences the lives of people and governs their actions. Compare the extent of this influence in the past with the present.

55. Arrange with a group of pupils to have a star and constellation hunting party. Select a clear moonless evening, decide upon a suitable meeting place and make the proper preparations which should include star charts and a focusing flashlight. Invite your instructor to attend and any parents

52. Make a gold dust (flash-on) star map. Draw on a cardboard the general shape of any one constellation. Make small pencil dots on this drawing to represent the different stars. With a speed-ball pen dipped into bronzing liquid, make small dots over the pencil dots. With a sharp pen or needle make a small hole through each painted dot. Show several of these objects to the class by darkening a room and placing a flashlight behind the cardboard.

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55. Arrange with a group of pupils to have a star and constellation hunting party. Select a clear moonless evening. Decide upon a suitable meeting place and make the proper preparations which should include star charts and a focusing flashlight. Invite your instructor to attend and any persons

who may wish to join you.

56. Write an original playlet depicting some important event in the history of aviation. When completed submit your manuscript to the teacher and if possible arrangements will be made for the playlet to be put on in the school auditorium.

57. Demonstration: Heated air is pushed up by cold air. Arrange a box about a foot long with a glass front and two holes in the top into which lamp chimneys may be fitted. Place candles inside the box under one of the holes. Light the candles and close the glass front. Dampen a paper towel and set on fire to produce smoke. Some practice is necessary to learn the right amount of dampening. Hold the smoking paper first over one chimney and then the other. In which one is the air rising and in which one is it descending? What is the path of the air currents inside the box? How does this compare with the movement of air in a heated room? How does this principle help flyers? (40:26)

58. Make a chart divided into two sections. Label one "Famous First Flights" and the other, "Famous Record Flights". Include dates, flyers, and occasion. (5:141-144)

59. On a large piece of oak tagboard draw a "Cross Section of the Atmosphere". Use poster paints or India ink. Label the different layers of the

atmosphere, cloud formations, and highest mountain peaks. (14:200) (3:8)

60. How to make a toy helicopter.[1]

a Drive two small nails into one end of a spool, on opposite sides of the hole and equal distances from it. Cut off the heads of the nails.

b To make a support, drive a large nail into one end of a piece of wood about four by one inches and cut off its head.

c Buy a six inch celluloid ruller and bore holes at equal distances from its center, to engage the nails in the spool. Make the holes a little larger than the nails. (To make propellers out of cardboard; cut strips six by one inches. Wet them, bend them into propeller shape, and let them dry in this shape overnight.)

d Put the ruler into boiling water until the celluloid is soft.

e Take it out and bend (twist) the ends of the ruler in opposite directions to make a propeller. Hold them until the celluloid cools and hardens.

f Wind a cord around the spool in such

1/ C. J. Lynde, Science Experiences with Home Equipment, Scranton, Pa., International Textbook Company, 1937. p. 31.

direction that when it is unwound it will turn the propeller in the right direction to rise. Put the propeller on the spool and the spool on the support.

Hold the support in one hand and pull the end of the cord hard with the other to twirl the spool. The propeller will spin and rise to a considerable height. (3:61-62)

Word objectives:

The pupil should know the meaning and or location or function of these words:

autogiro
helicopters
immersed
hydrogen
helium
airfoil
fuselage
drag
thrust
gravity
inertia
alloys
plywood
plastics
density
rudder
horizon
troposphere
stratosphere
cumulus clouds
nimbus clouds
cirrus clouds
anoxia
air mass
altitude
flaps
stabilizer
wing panel
canopy
warm and cold fronts
contact flying
celestial navigation
latitude & longitude
great circle
aileron
elevator
variation
deviation
true north
barometric pressure
north star
big - small dippers
precipitation

Evaluative Activities

- Men Fly -- The Airplane Now and in the Future

I. Objective test on the unit.

Section A: True - False Items

Instructions: In the proper spaces below write a plus (+) if true, write a minus (-) if false.

(+) 1. Balloons are termed lighter-than-aircraft.

(-) 2. The first glider flight was made by Orville Wright in 1883.

(-) 3. Both Polar Regions were reached via air by Charles Lindbergh.

(+) 4. Captains Stevens and Anderson reached the stratosphere in a large balloon in 1935.

(+) 5. Drag is one of the forces that opposes lift.

(-) 6. Gravity is a force helpful to flying.

(+) 7. Thrust is a force that pulls an airplane through the air.

(-) 8. Barrage balloons played an important part in World War II.

(+) 9. Duraluminum is an alloy used a great deal in modern airplane construction.

(-) 10. Civil Aeronautic Authorities do not require pilots to file a flight-plan before making cross-country trips.

(+) 11. Celestial navigation is a great help to pilots on clear nights.

(+) 12. Pilots must have a clear understanding of latitude and longitude lines.

(-) 13. Air routes in the United States do not follow the Overland Trail.

(+) 14. Much first-class mail is carried by airplanes.

(-) 15. Air transportation is not safeguarded.

(+) 16. There are four main types of clouds.

(+) 17. Cumulus clouds are towering, rounded masses with flat bases.

(-) 18. The ailerons are located at the tail section of an airplane.

(+) 19. Stratosphere is the layer of space above the troposphere.

(-) 20. Flaps are used to help increase an airplane's speed.

Section B: Completion

Instructions: Complete the following statements.

1. The first non-stop flight across the Atlantic was made by (Charles Lindbergh) in 1927.
2. Helium is superior to (hydrogen) for use in balloons and dirigibles.
3. A variety of (weather) conditions provide hazards for the aviator.
4. A motorless craft is called a (glider) or a (balloon).
5. An aircraft having a fan-like propeller above the fuselage is called (helicoptor).

(+) 16. There are four main types of clouds.

(+) 17. Cumulus clouds are towering, rounded masses with flat bases.

(-) 18. The ailerons are located at the tail section of an airplane.

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Section B: Completion

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3. A variety of (weather) conditions provide hazards for the aviator.

4. A motorless craft is called a (glider) or a (balloon).

5. An aircraft having a fan-like propeller above the fuselage is called (helicopter).

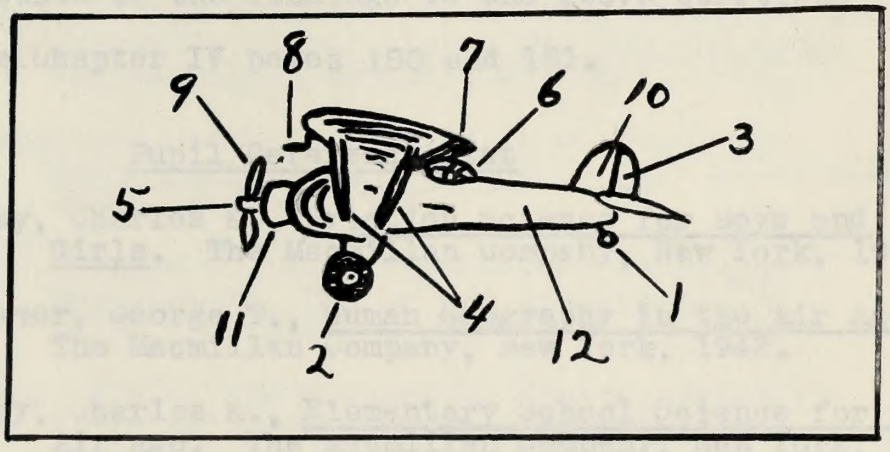
Section C: Matching

Instructions: Place in the blank at the left the number of the item which it identifies.

(11)	canopy	1. Using stars and planets for direction.
(7)	fuselage	2. P-39; P-40.
(8)	plywood	3. Affects horizontal direction.
(12)	bombers	4. Air disease.
(2)	fighter-planes	5. Acts same as a fin or keel.
(1)	celestial navigation	6. Affects weather.
(14)	contact flying	7. Main body of airplane.
(3)	rudder	8. A sandwich of wood and glue.
(13)	aileron	9. Area of space below stratosphere.
(5)	stabilizer	10. Great circle lines.
(9)	troposphere	11. Place where pilot sits.
(4)	anoxia	12. B-17; B-29.
		13. Affects vertical direction.
		14. Using ground objects for direction.

Section D: Identification

Instructions: Identify the listed items in the drawing and write the number in the space beside the name of object it identifies.



(3)	rudder	(6)	canopy
(7)	aileron	(9)	propeller
(10)	stabilizer	(11)	cowling
(12)	fuselage	(1)	tail wheel
(2)	landing gear	(5)	pitch control
(4)	struts	(8)	altimeter extension

Section C: Meaning

Instructions: Place in the blank at the left the number of the item which it identifies.

(1) canopy
(2) fuselage
(3) glycogen
(4) bombers
(5) fighter-planes
(6) celestial navigation
(7) combat flying
(8) rudder
(9) aileron
(10) stabilizer
(11) tropopause
(12) anoxia

1. Using stars and planets for direction.
2. F-39; F-40.
3. Affects horizontal direction.
4. Air disease.
5. Acts same as a fin or keel.
6. Affects weather.
7. Main body of airplane.
8. A sandwich of wood and glue.
9. Area of space below stratosphere.
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14. Using ground objects for direction.

Section D: Identification

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(3) rudder
(7) aileron
(10) stabilizer
(18) fuselage
(5) landing gear
(4) struts

(6) canopy
(9) propeller
(11) cowling
(1) tail wheel
(15) pitch control
(8) altimeter extension

II. Pupil reactions to the unit.-- At the conclusion of the second unit for purposes of additional evaluation of the method, the pupils were asked to give candid and, if desired, anonymous answers to the following questions:

1. What did you like best about the way we studied aviation unit, Men Fly?
2. Was there anything you did not like about the way the work was done?
3. What is your opinion of the optional related activities?
4. What activities did you find most interesting?
5. What activities did you find least interesting?
6. Feel free to make additional comments if you wish to.

The results of the findings to the above questions are found in Chapter IV pages 180 and 181.

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21. Craig, Gerald S., Margaret G. Condry, Katherine E. Hill, From Sun to Earth. Ginn and Company, Boston, 1940.

22. Huey, Edward G., What Makes the Wheels Go Round. Reynal and Hitchcock, New York, 1940.

23. Wilson, Charles C., M. D., Helen B. Pryor, M.D. and John C. Almack, Ph.D., The American Health Series, Growing Healthfully, Book VI. The Bobbs-Merrill Company, New York, 1942.

24. Collins, Francis A., The Boys' Book of Model Aeroplanes. The Century Company, New York, 1929.

25. Levin, Lawrence M., Ph.D., Do It Yourself, For Boys and Girls. The Grolier Society Inc., New York, 1945.

26. Wright, Bailey, James J. Smiley, Jr., and Rex Martin, Flight, First Principles. American Technical Society, Chicago, 1941.

27. Allen, Hugh, The Story of the Airship. Goodyear Tire and Rubber Company, Akron, 1932.

28. Jordanoff, Assen, Your Wings. Funk & Wagnalls Company, New York, 1938.

29. Fall, Delos, Science for Beginners. World Book Company, New York, 1927.

30. Johnston, S. Paul, Flying Fleets. Duell, Sloan and Pearce, New York, 1941.

31. Wright, Bailey, E. W. Dyer, and Rex Martin, Flight Construction and Maintenance. American Technical Society, Chicago, 1941.

32. Carpenter, Harry A. and George Wood, Our Environment, How We Adapt Ourselves to It. Allyn and Bacon, Boston, 1946.

33. Carpenter, Harry A., Guy A. Bailey, and M. Elizabeth Tuttle, Adventures in Science -- 4. Allyn and Bacon, Boston, 1945.

34. Carpenter, Harry A., Guy A. Bailey, and M. Elizabeth Tuttle, Adventures in Science -- 5. Allyn and Bacon, Boston, 1945.

35. Carpenter, Harry A., Guy A. Bailey, and M. Elizabeth Tuttle, Adventures in Science -- 6. Allyn and Bacon, Boston, 1945.

36. Jordanoff, Assen, Safety in Flight. Funk & Wagnalls Company, New York, 1941.

37. Wylie, C. C., Our Starland. Lyons & Carnahan, New York, 1942.

38. T. W. A. Air Transportation. 8th Edition pamphlet, 1946.

39. Johnston, S. Paul, Flying Squadrons. Duel, Sloan and Pearce, New York, 1942.

40. Arey, Charles K., Science Experiences for Elementary Schools. Bureau of Publication, Teachers College, Columbia University, New York, 1942.

Classified annotated bibliography.-- An extensive study of aviation books and stories was made and classified as to type of reading. The entire collection, listed on the following pages, was made available to the pupils and the English (reading) teacher during the teaching of the units. The majority of the books were in the school system, while the others were procured with cooperation from the town library as well as the Boston University library. The books and stories were read as part of the work of the units and much of the reading was done in cooperation with the reading teacher. A complete report of the number of books and stories read by the pupils is tabulated in Chapter IV.

Classified annotated bibliography.-- An extensive study of aviation books and stories was made and classified as to type of reading. The entire collection, listed on the following pages, was made available to the pupils and the English (reading) teacher during the teaching of the units. The majority of the books were in the school system, while the others were procured with cooperation from the town library as well as the Boston University library. The books and stories were read as part of the work of the units and much of the reading was done in cooperation with the reading teacher. A complete record of the number of books and stories read by the pupils is tabulated in Chapter IV.

Classified Annotated Bibliography

Basal Readers

Baker, Clara B., and Edna D., The Earth We Live On, Bobbs-Merrill Company, New York, 1937.
"The Giant Dragon Fly" p. 220-230.
A story of a Navajo Boy who wanted to fly, and upon seeing an airplane, thought it was a giant dragon fly. He did have his wish and was taken up for an airplane ride.
(Curriculum Readers - 4) 1/

Baker, Clara B., and Edna D., Our World and Others, Bobbs-Merrill Company, New York, 1938.
"First Dawn-to-Dusk Flight" p. 59-71.
How a letter given to an aviator at early dawn in New York, was delivered at sunset that same day in San Francisco.
(Curriculum Readers - 6)

Gates, Arthur I., and Jean Ayer, Let's Look Around, The Macmillan Company, New York, 1940.
"Playing Airplane" p. 340-361.
A story, explaining simply, how flying in an airplane is done.
"A Famous Flight" p. 364-374.
A story of Charles Lindbergh's flight across the Atlantic.
"The Sky-Writer" p. 378-383.
A class of fourth grade children write to a pilot who is a sky-writer, and in reply he answers their questions on how sky-writing is done.
"The Dirigible" p. 377.
A poem.
"Flight" p. 385-386.
A poem.
(4)

Gates, Arthur I., and Jean Ayer, Let's Go Ahead, The Macmillan Company, New York, 1940.
"Story of Orville and Wilbur Wright" p. 367-390.
Tells the story of their boyhood interest in toy flying machines, and how it lead to successful flight in an airplane of their own.
(6)

1/ Numerals signify grade-level of reading matter.

Hahn, Julia L., Tales and Travel. Houghton Mifflin Company, Boston, 1943.
"Flying Across the Pacific" p. 366-373.
The story of a China Clipper's flight from California to Manilla in the Phillipines.
"Dirigibles" p. 376-383.
A brief description of the dirigible, and what keeps it in the air. Also the stories of the Graf Zeppelin and the Hindenburg.
"A Map for Flyers" p. 385-396.
A description and explanation of the maps used by flyers, illustrated with maps.
"The Giant Bird" p. 365.
A poem.
"The Zeppelin" p. 375.
(5)

Hildreth, Gertrude, and others, Today and Tomorrow. John C. Winston Company, Philadelphia, 1943.
"We Go by Air" p. 277-312.
The story of Mr. and Mrs. Hutchinson and their two daughters, and their flight by plane to Greenland. At each stop the girls have an adventurous time. Their seaplane is forced down among icebergs, and the family narrowly escapes going down with the plane.

"Travelling by Air" p. 314-327.
Gives a description of the comforts of travelling in an airliner, the tests one must pass to be an air pilot, the work of the plane mechanics, the airfield terminal, and how pilot and control tower work together.
(Easy Growth in Reading - 4)

Horn, Earnest, Maude McBroom and Ruth H. Bishop, People and Places. Ginn and Company, Boston, 1940.
"The Test Pilot" p. 107-117.
The story of Jim's father who was a test pilot for the United States Army. On one test flight, the wing of the plane broke off and Jim's dad had to bail out, but he sustained no injuries.
(Progress in Reading - 3)

Nolen, Barbara, Fun and Frolic. D. C. Heath and Company, Boston, 1942.
"The First Balloon Ride" p. 172-179.
Story of the first balloon which was filled with smoke and hot air to make it rise. Its three passengers on this first flight were a sheep, a duck, and a rooster.
(Reading for Interest - 4)

Hildreth, Gertrude. and others. Today and Tomorrow. John C. Winston Company. Philadelphia. 1943.
"We Go by Air" p. 297-312.
The story of Mr. and Mrs. Hutchinson and their two daughters, and their flight by plane to Greenland. It soon ends the girls have an adventurous time. Their seaplane is forced down among icebergs, and the family narrowly escapes going down with the plane.

"Traveling by Air" p. 314-327.
Gives a description of the comforts of traveling in an airliner, the tasks one must pass to be an air pilot, the work of the plane mechanics, the airfield terminal, and how pilot and control tower work together.
(Easy Growth in Reading - 4)

Horn, Barnes, Wanda Bottcom and Ruth H. Bishop. People and Places. Ginn and Company. Boston. 1940.
"The Test Pilot" p. 107-117.
The story of Jim's father who was a test pilot for the United States Army. On one test flight, the wing of the plane broke off and Jim's dad had to bail out, but he sustained no injuries.
(Progress in Reading - 5)

Nolen, Barbara. Run and Frolic. D. C. Heath and Company. Boston, 1942.
"The First Balloon Ride" p. 172-179.
Story of the first balloon which was filled with smoke and not air to make it rise. The three passengers on this first flight were a sheep, a duck, and a rooster.
(Reading for Interest - 4)

Nolen, Barbara, The Brave and The Free. D. C. Heath and Company, Boston, 1942.
"The Runaway Plane" p. 86-95.
The story of a pilot who was forced to land his seaplane on Lake Michigan. Both he and his dog have a narrow escape when they accidentally fall into the water, and barely get back to the plane which the wind was moving.
"Sky High" p. 139.
A poem of a Navy seaplane.
(Reading for Interest - 6)

O'Donnell, Mabel, Engine Whistles. Row, Peterson and Company, New York, 1942.
"Headlines" p. 228-249.
The story of a homecoming celebration for the Wright Brothers in 1910 in the city of Hastings, after their successful plane flight. After several attempts and reverses, the queer looking flying-machine flew for almost an hour above the city of Hastings.
"Headlines" p. 353-371.
The story of a flight aboard an airliner, the Trail Blazer.
(Alice and Jerry Books - 5)

Palmer, Robin, and Edna Potter, Lost and Found. D. C. Heath and Company, Boston, 1942.
"Airplane Ride" p. 214-238.
A story of David and Holly who lived near an airport. Their father was a pilot. They go up for a ride in an airplane, and give their teddy bear a parachute ride.
"Away in My Aeroplane" p. 240-241.
A poem.
"The Dirigible" p. 243.
A poem.
(Reading for Interest - 3)

Spencer, Paul R., and Lois D. Fritschler, Exploring New Trails, Lyons and Carnahan, New York, 1945.
"Sky Navigators" p. 66-74.
A story of the help that is given to airplane pilots to make sky navigation safe for passengers.
(5)

Spencer, Paul R., and Lois D. Fritschler, Traveling New Trails. Lyons and Carnahan, New York, 1945.
"Flying Freighters" p. 433-440.
The story of carrying express and freight by air. Tells the kinds of goods and how far they are carried.

"Travel Wings" p. 441-450.
The story of the improvements made in airplane travel in the last few years.
"Ace of Aces" p. 454-458.
A brief history of the career of Eddie Rickenbacker.

(6)

Yoakam, Gerald, M. M. Veverka, and Louise Abney, From Every Land. Laidlaw Brothers, Inc., New York, 1941.
"Flight to Hawaii" p. 251-264.
The story of two men in a plane, far from land. The radio is not working, and the gas supply is low. They are flying toward Hawaii from Oakland, California. Through skillful handling of the plane, they make a forced landing on one of the Hawaiin Islands. Even so, they have made a record flight.

"They Fly Through the Air" p. 265-266.
A poem which compares the circus acrobat with the airplane pilot.
(Laidlaw Basic Readers - 6)

Stories and Fiction

Anderson, Lonzo, Bag of Smoke. Viking Press, New York, 1942. $2.00.
An amusing story of the first balloon. Setting is in France.
(5-8)

Brier, Howard M., Sky Freighter. Random House, Inc., New York, 1942. $2.00.
A story of bush pilots who fly freight to the radium mines of Artic Canada.
(7-9)

Brier, Howard M., Skyblazer. Junior Literary Guild, Random House, Inc., New York, 1946.
Story of Barry Martin, experimental pilot, in a stratosphere airliner goodwill trip to South America. Much mystery and adventure.
(7-9)

Davis, L. R., Spinney and Spike and the B-29. Charles Scribner's Sons, New York. $1.75.
Interesting story of two boys' experiences visiting the A.A.F.
(5-7)

Hall, C. G., Skyways. The Macmillan Company, New York, 1941. $1.75.
An interesting story of airplane history. Well illustrated.
(6-8)

Hurd, Edith Thatcher, Sky High. Lothrop, Lee and Shepard Company, New York, 1941. $1.00.
Interesting juvenile story of a flight in an airliner. Attractively illustrated.
(4-6)

Huber, M. B., F. S. Salisbury and A. I. Gates, Planes for Bob and Andy. The Macmillan Company, New York, 1944. $1.12.
How two boys achieved their ambition to become pilots. Covers the field of aviation history, the period of expansion between the two wars. Illustrated.
(Aviation Readers - 3)

Lent, Henry B., The Air Pilot. The Macmillan Company, New York, 1937. $.35.
A trip in an airliner with many colored illustrations.
(3-5)

Lent, Henry B., Flight 17. The Macmillan Company, New York, 1940. $1.00.
Excellent story of a flight by airliner, told in narrative form. Tells of the workings of the plane, and the contributions all the various people make to the flight.
(4-6)

Lent, Henry B., Aviation Cadet. The Macmillan Company, New York, 1941. $1.175.
Dick Hilton wins his wings at Pensacola. Training of a Navy flyer told in fictional form. Illustrated.
(7-9)

Miller, Blaine and Dupont, Bob Wakefield; Naval Aviation. Dodd, Mead and Company, New York, 1941. $2.00.
Short stories about the experiences and adventures of a popular hero pilot.
(7-9)

Miller, Blaine and Dupont. Bob Wakefield's Flight Log. Dodd, Mead and Company, New York, 1941.
Ten stories which carry on the experiences of Bob Wakefield.
(7-9)

Nay, Carol, Timmy Rides the China Clipper. Albert Whitman and Company, Chicago, 1939. $1.50.
A colorful Pacific trip by a boy which tells the sights he saw. Interesting maps.
(5-7)

Norling, Jo and Earnest, Pogo's Sky Ride. Henry Holt and Company, New York. $1.25.
Nicely illustrated child's story of a visit to an airplane factory and a plane ride.
(3-5)

Petersham, Maud and Miska, The Story Book of Aircraft. John C. Winston Company, Chicago, 1935. $.60.
Short stories based on the development of the airplane. Colorfully illustrated.
(3-5)

Phillips, Josephine E., On The Airways. Row, Peterson Company, 1942. $.32.
Story of a boy's flight across the continent. Much worthwhile aviation material. Well illustrated.
(Basic Social Education Series -4-6)

Pollock, Katherine, Sky Ride. Charles Scribner's Sons, New York, 1929. $1.75.
Story of two air-minded boys, their adventures at a nearby flying field, and how they learned to fly. Illustrated.
(4-6)

Pryor, William C., and Helen S., The Dirigible Book. Harcourt, Brace and Company, New York, 1936.
Photographic Picture-Book with a story. Contains much to stimulate the interest of elementary school children in the possibility of further use of airships.

Taylor, Florence W., Navy Wings of Gold. Albert Whitman and Company, Chicago, 1944.
The story of three youth's cadet training in becoming pilots, from preliminary pre-flight to graduation with Navy Wings.

Tousey, Sanford, Airplane Andy. Doubleday and Company, New York, 1942. $1.100.
Story of Andy's trip to Washington in an airliner, the pilot being his father. Andy aids in bringing the plane to safety through a storm. Much information is included in the narrative.
(3-5)

Wood, Esther, Silver Widgeon. Longmans Green and Company, New York, 1942. $2.00.
The story of two small boys, eight and ten, who are taken on the airplane trip to Canada, and prove their resourcefulness when the plane has to make a forced landing in the wilderness.
(4-6)

History

Allen, C. B., and L. D. Lyman, The Wonder Book of the Air. John C. Winston, Philadelphia, 1941. $2.50.
Story of man's conquest of the air and first hand description of actual flights. Well illustrated with photographs and maps. Excellent.
(6-9)

Carlisle, Norman, Reginald Cleveland, and Jonathan Wood, The Modern Wonderbook of the Air. John C. Winston Company, Philadelphia, 1945.
A comprehensive, historical treatment of aviation in all its phases. Especially valuable for its photographs.

Cohen, Rose E., The Man Who Gave Us Wings. The Macmillan Company, New York. $1.08.
Gives the history of aviation from the earliest legends of Daedalus and Icarus, to the day when man's dreams of flying finally realized. Illustrated with half tones and drawings.
(Aviation Readers - 5)

Crump, Irving and John W. Newton, Our Airmen. Dodd Mead and Company, Inc., New York, 1936. $2.00.
The story of aviation in its many phases taken from the point of view of the men who fly the ships. Illustrated with photographs.
(7-9)

Crump, Irving and Norman Maul, Our Airliners. Dodd Mead and Company, Inc., New York, 1940. $2.00.
The story of air transportation is traced from the early mail lines to the present day. Detailed descriptions given of scheduling flights, radio beams, and training of airline pilots.
(7-9)

Dunn and Morrisett, Wings for America. World Book Company, New York, 1943. $1.00.
Comprehensive treatment, with good emphasis on history and social implications for intermediate level.

Fraser, Chelsea, Heroes of the Air. (Revised Edition) Thomas Y. Crowell Company, New York, 1940. $2.50. Beginning with the first flight across the ocean in 1919, it traces the outstanding flights by men and women in chronological order up to 1940. (7-9)

Fraser, Chelsea, The Story of Aircraft. Thomas Y. Crowell Company, New York, 1944. $2.50. A complete description of aircraft with historical approach. Illustrated with photographs and diagrams. (7-9)

Fraser, Chelsea, Famous American Flyers. Thomas Y. Crowell Company, New York, 1941. $2.50. Separate stories of men and one woman who made some contribution to the science and development of flying in its various fields. Illustrated with photographs and maps. (7-9)

Gregory, H. F., Anything A Horse Can Do. Reynal and Hitchcock, New York, 1944. The story of the helicopter-its history and development. Illustrated with photographs and diagrams.

Johnson, Paul S., Flying Fleets. Duell, Sloane and Pearce, New York, 1941. A short written history of United States Navy Aircraft, with 219 photographs beginning with the Navy's first experimental craft. Recommended for its photos.

Loening, Grover, Our Wings Grow Faster. Doubleday, Doran and Company, Garden City, New York, 1935. Personal episodes of a lifetime in aviation by the author. Gives good historical and pictorial record.

Maizlish, Leon I., Wonderful Wings. Row, Peterson and Company, Evanston, Illinois. Historical treatment of the story of aviation.

Smith, Henry L., Airways. Alfred A. Knopf, New York, 1942. A history of commercial aviation in the United States.

Washburn, Stanley, Bamboo to Bombers. Albert Whitman and Company, Chicago, 1941. $1.00. Short history of aviation, depicting and describing its outstanding achievements from the time of Leonardo da Vinci's flying machine to the present day United States bomber. Illustrated. (3-5)

Science

Arey, Charles K., Aviation Science for Boys and Girls. The Macmillan Company, New York, 1944. $1.12. Explains the elementary principles of flight, functions of various parts of a plane, and their construction. Takes up navigation, and the weather. Illustrated with half tones and diagrams. (Aviation Reader -6)

Arey, Charles K., Air-Age Education Series, Elementary School Science for the Air Age, The Macmillan Company, New York, 1942.
This is a worthy book treating the subject of aviation at the elementary school level. It furnishes the teacher the subject-matter topics, how to present them to the class and the level at which each topic should be taught. It is a technical reference book highly digested with practical subject matter. There are many worthwhile experiments described and illustrated.

Aviation Education Research Group, Teachers College, Columbia University, Science of Pre-Flight Aeronautics. Air-Age Education Series, The Macmillan Company, 1942.
A students' text for pre-flight aeronautics courses. The subject areas included were carefully analyzed by professional educators in cooperation with consultants from the Civil Aeronautics Administration, the Army and Navy air services, and the United States Office of Education. These areas are sufficiently comprehensive to serve for courses of 2, 3, or 4 semesters, according to local requirements. A number of school systems, public, private, and parochial, assisted in the development and selection of materials. The materials were checked for authenticity by subject matter experts in the various fields covered. A glossary of terms is included. 700 illustrations. The seven divisions of the text are:

Principles of Airplane Structures
Human Factors in Flight
Aerodynamics
Airplane Engines
Meteorology
Communications A
Air Navigation

Science

Aviation Research Associates, Young America's Aviation Library. Harper and Brothers, New York, 1943.
Parts of Planes, 1943. $1.00.
Simple explanation of engine, propeller, and instruments. Many diagrams.
(4-7)
Types of Planes, 1943. $1.00.
Explanation of principal types of planes and identification features. Many diagrams.
(4-7)
How Planes Fly, 1943. $1.00.
Explanation of principles of flight. Many diagrams.
(4-7)
Planes in Action, 1944. $1.00.
Explanation of the controls of a plane and the various maneuvers. Many diagrams.
(4-7)
How Planes are Made, 1945. $1.00.
Explanation of the planning and work of the designers in constructing new planes.
(4-7)
How Planes Get There, 1945. $1.00.
Explanation of air navigation, and the use of instruments. Many diagrams.
(4-7)

Baughman, Harold E., Baughman's Aviation Dictionary and Reference Guide; Aero-Thesaurus. Aero Publication, Glendale, California, 1940.
This book is arranged in three major sections; including a dictionary of aviation terms and abbreviations; a dictionary of information, including C.A.A. regulations, valuable flight information, a directory, a list of aeronautical publications and occupations. It is an excellent source book and contains illustrations.

Black, Archibald, The Story of Flying. Whittlesey House (McGraw-Hill Book Company, Inc.) New York, 1940.
Gives historical treatment.

Brookes, Bernard, How to Fly an Airplane. Consolidated Book Publishers, Inc., Chicago, 1942.
Basic flight instruction. Well illustrated with photographs and diagrams.

Craig, Gerald S., Goldie M. Johnson, and June E. Lewis, The Earth Then and Now. Ginn and Company, Boston, 1940.
"Man Invents an Airplane"
"What Keeps an Airplane in the Air?" p. 420-427.
(New Pathways in Science - 6)

Aviation Research Associates. Young America's Aviation Library. Harper and Brothers, New York, 1943.
Parts of Planes. 1943. $1.00.
Simple explanation of engine, propeller, and instruments. Many diagrams.
(4-7)

Types of Planes. 1943. $1.00.
Explanation of principal types of planes and identification features. Many diagrams.
(4-7)

How Planes Fly. 1943. $1.00.
Explanation of principles of flight. Many diagrams.
(4-7)

Planes in Action. 1944. $1.00.
Explanation of the control of a plane and the various maneuvers. Many diagrams.
(4-7)

How Planes are Made. 1945. $1.00.
Explanation of the planning and work of the designers in constructing new planes.
(4-7)

How Planes Get There. 1945. $1.00.
Explanation of air navigation, and the use of instruments. Many diagrams.
(4-7)

Bowman, Harold R. Bowman's Aviation Dictionary and Reference Guide; Aero-Thesaurus. Aero Publications, Glendale, California, 1940.
This book is arranged in three major sections; including a dictionary of aviation terms and abbreviations; a dictionary of information, including C.A.A. regulations, valuable flight information, a directory, a list of astronautical publications and occupations. It is an excellent source book and contains illustrations.

Black, Archibald. The Story of Flying. Whittlesey House (McGraw-Hill Book Company, Inc.) New York, 1940.
Gives historical treatment.

Brooke, Bernard. How to Fly an Airplane. Consolidated Book Publishers, Inc., Chicago, 1942.
Basic flight instruction. Well illustrated with photographs and diagrams.

Craig, Gerald S., Goldie M. Johnson, and Irma E. Lewis. The North Then and Now. Ginn and Company, Boston, 1940.
"Man Invents an Airplane"
"What Keeps an Airplane in the Air?" p. 430-437.
(New Pathways in Science - 6)

Craig, Gerald S., Science for the Elementary School Teacher, Ginn and Company, Boston, 1940.
This is a large volume of 551 pages for the science teacher. It states the place of science education in education and covers all the important science topics with descriptions as to how to present them to the pupils. Well illustrated. Teachers should gain a conception of science in terms of its contributions to the method of the classroom.

Craig, Gerald S., Margaret G. Condy, and Katherine E. Hill, From Sun to Earth. Ginn and Company, Boston, 1940.
"What is the Weather?"
"The Weather Bureau".
"A School Weather Station" p. 180-203.
(New Pathways in Science - 5)

Duncan, Richard, Air Navigation and Meteorology; 4th ed. Goodheart-Willcox, Chicago, 1941.
This book contains a comprehensive account, in nontechnical language, of air navigation and meteorology for pilots.

Fitzpatrick, F. L., and K. A. Stiles, The Biology of Flight, Air-Age Education Series, The Macmillan Company, New York, 1942.
This book contains a discussion of organisms that fly, types of flight, the effects of pressure and temperature in aviation, other altitude effects, positive and negative acceleration, the sense organs and flight, physical fitness for flight and the relationship of air transportation and disease control. The book is well illustrated.

Fitzpatrick, F. L., and K. A. Stiles, Teachers Manual for the Biology of Flight, Air-Age Education Series, The Macmillan Company, New York, 1942.
This manual contains suggestions for teaching the Bilogy of Flight, either as a part of other courses or as a separate course and for the use of demonstration, specimens, tests, charts, and classroom discussions in the course.

Gillmer, Thomas C., and Herman E. Nietsch, Simplified Theory of Flight. Van Nostrand, New York, 1941.
This is a simplified discussion of aerodynamics for student pilots and others interested in understanding the physical laws which operate in flight. Well illustrated.

Appendix:

A. Effects of flying on the pilot.
B. Effects of flaps on the airplane flight.
C. Aerodynamic glossary of great value to the teacher.

Grimm, Dorothy R. H., Junior Aviation Science. Noble and Noble Publishers, Inc., New York, 1942. $.90.
A simple and scientific approach to ground work in Air Education. The practical application of science and scientific principles to aviation. Minimum essentials of aeronautics.
(6-9)

Jordanoff, Assen, Flying and How To Do It. Crossett and Dunlap, New York, 1940. 124 p.
Cleverly illustrated and authoritative explanation of the art of flying. Written in simple terms by an experienced airman.

Jordanoff, Assen, Aviation Dictionary. Harper and Brothers, New York, 1942.
Comprehensive reference book. Well illustrated.

Jordanoff, Assen, Through the Overcast; The Art of Instrument Flying. Funk-Wagnalls Company, New York, 1938.
This book is a textbook for student pilots on meteorology, air navigation, aircraft instruments, radio guided flight, and related topics. The discussion of each topic is related to a diagram. Well illustrated.

Mc Clintock, Marshal, Airplanes and How They Fly. Frederick A. Stokes, Philadelphia, 1943. $2.00.
A primer of aviation for young people who want to understand why and how a plane flies. Explains principles of aerodynamics. Illustrated.
(6-9)

Parker, Bertha M., Basic Science Education Series, Row, Peterson Company, New York.
Ask the Weather Man, 1941. $.32.
Instruments, maps, and forecasts.
(4-6)
The Ways of Weather, 1941. $.32.
Pressure, winds, and precipitation simply presented.
(4-6)
Clouds, Rain and Snow, 1941. $.32.
Story of formation and ways of these weather elements.
(4-6)

The Air About Us, 1941. $.32.
Qualities of air, the wind, toys using air.
Our Ocean of Air, 1941. $.32.
Air pressure and its applications.
(4-6)

Petterssen, Sverre, Introduction to Meteorology, McGraw-Hill Company, New York, 1941.
An elementary text in the basic principles of modern meteorology. It is clearly written in a somewhat condensed style and includes weather maps.

Pickwell, Gayle, Weather, McGraw-Hill Company, New York, 1938.
This book has fifty-four full-page photographs of weather phenomena and weather maps, accompanied by a readable discussion of some of the causes, signs, and work of weather. The book includes a chapter on man's adaptation to weather and his attempts at forecasting.

Shenton, Edward, New Alphabet of Aviation, Macrae-Smith and Company, Philadelphia, 1941. $2.00.
All illustrations of aviation terms, planes and action, are in alphabetical order. Contains pictures in two colors on every page.
(4-6)

Sloane, Eric, Clouds, Air and Winds, Devin-Adair Company, New York, 1941.
An artist's description of clouds and their formation and characteristics, and a primer of flight meteorology. The book includes material of interest on air and wind and their relation to weather. It is written for the layman.

Rotter, G. E., Jimmy Learns About Airplanes, University Publishers, New York, 1944. $.44.
A story teaching principles of flight.

Smith, Nila B., A Look at the Weather, Silver Burdett Company, New York, $.16.
Simplified booklet on the weather.

Sorenson and Rotter, Now We Fly, John C. Winston and Company, Philadelphia, 1944.
Explains the principles of flight, what a trip by airliner is like, and the workers in aviation. Illustrated with photographs.
(4-6)

Storer, John, Bird Flight and Aviation, Devin-Adair Company, New York, 1943. $3.00.
A discussion of bird flight from the aerodynamic point of view. Large illustrations and charts.

Vetter, Earnest G., Let's Fly: An A.B.C. of Flying, William Morrow and Company, New York, 1940.
Simple, direct instructions on how to fly.

Wenstrom, William H., Weather and the Ocean of Air, Houghton-Mifflin Company, Boston, 1942.
An interesting book for laymen who wish to obtain an understanding of the causes of various weather phenomena and the means of forecasting. It describes the importance of meteorology to aviation. It is clearly written and well illustrated.

Military

Booth, Harold, H., Book of Modern Warplanes, Garden City Publishing Company, New York, 1942. $1.00.
A picture book of planes with descriptions of each plane.
(4-8)

Cooke, David C., (editor) Young America's Annual, Robert M. McBride and Company, New York, 1944.
Photographs and pertinent data on airpower, Army Air Forces, military air transport, fundamentals of air fighting, and the manufacturing industry.
(7-9)

Cooke, David C., (editor) Young America's Aviation Annual, Robert M. McBride and Company, New York, 1945.
Photographs and pertinent data on air power, Army and Navy Aviation, B-29 Fortress, flying health, and the manufacturing industry.
(7-9)

Cooke, David C., War Wings, Robert M. McBride and Company, New York, 1941.
Fighting planes of the American and British Air Forces. Highly recommended for its photographs.

Hinert, Reed C., America's Fighting Planes, The Macmillan Company, New York, 1943. $2.50.
A pictorial record of all American military planes in action in May 1943. Description and figures accompany author's striking picture of the different planes. (5-9)

Law, Bernard, Fighting Planes of the World, Random House Inc., New York, 1942.
An illustrated book of warplanes.

Munday, Albert H., Captains of the Sky, Row, Peterson Company, Evanston, Illinois, 1942.
Brief description of military aviation in past and present. Many illustrations.

Walker, John B., War in the Air, Random House Inc., New York, 1941. $1.00.
Fighting planes and pilots in action. Well illustrated.
(6-8)

Career

Air Youth of America, Youth in Aviation, Appleton-Century Company, New York, 1941.
Book designed to meet needs of the group leader or instructor in planning a model airplane program, the tools and equipment necessary, and much general information. Well illustrated with photographs and diagrams.

American Airlines, Opportunities for Youth in Air Transportation, New York. $.25.
An interesting booklet outlining airline work.

Floherty, John J., Aviation From Shop to Sky, J. B. Lippincott Company, New York, 1941. $2.00.
Tells about airplane building and flying, both military and commercial--the engineers, designers, mechanics, and pilots who work on them. Illustrated.
(7-9)

Keliher, Alice, V., Air Workers Today, Harper and Brothers New York, 1942. $1.00.
Simple graphic presentation of aviation opportunities. Many illustrations.
(6-9)

Knerr, Hugh J., The Student Pilot's Training Primer, Van Nostrand, New York, 1941.
This book is a text book for pre-flight instruction in the theory of flight, necessary physical reactions of the body while flying, and the art of flying. It is a simple and readable book on how to fly.

Leyson, Burr W., Aeronautical Occupations, Dutton Company, New York, 1941. $2.00.
For those interested in aviation as a career. It covers the field of major occupations in aviation. Details as to training for each job.
(7-9)

Meyer, Dickey, Needed-Women in Aviation, Robert M. McBride and Company, New York, 1942.
Women in uniform, women in aircraft manufacturing, women in commercial profession. Illustrated.

Peckham, Betty, Sky Hostess, Thomas Nelson and Sons, New York, 1941. $1.75.
Interesting story of work of an airline stewardess.

Ray, Ermine Levi and Stanley Washburn, Are You Fit to Be a Pilot, Wilcox and Follet Company, New York, 1941.
A series of flight physical tests of the eyes, ears, balance, circulation, and muscular control. Illustrated with photographs. An interesting book for the classroom.

Rifkin, L., When I Grow Up I'll be a Flyer, Lothrop, Lee and Shepard, New York, 1942. $1.25.
Story of pilot training in simple, non-technical language. Illustrated with photographs.
(4-6)

Roan, C. M., Wings on the Air, Bernard Ackerman, Inc., New York. $1.00.
Outlines travel by airliner and opportunities.

United Air Lines, Air Transportation Jobs and You, New York, free.
An interesting guidance booklet on opportunities in the airlines.

Williams,Henry L., Keep 'Em Flying! Row Peterson, Evanston, Illinois, 1942. $.96.
Description of the apprenticeship training for aviation mechanics. Well illustrated. Told in conversational style.

Aviators

Byrd, Richard E., Skyward, G. P. Putnam's Sons, New York 1928.
The flying experiences, including trans-Atlantic flights, and flight to the North Pole, told by a famous explorer. (7-9)

Corrigan, Douglas, That's My Story, E. P. Dutton and Company, New York, 1938.
The story of the author's life and his flight across the Atlantic, 56 Gravure illustrations.
(7-9)

Earhart, Amelia, 20 Hrs. 40 Min.; Our Flight in the Friendship, G. P. Putnam's Sons, New York, 1928.
The flying experiences, in autobiography form, of the first American woman to cross the Atlantic.
(7-9)

Felson, Henry, Pilots All, Harper and Brothers, New York, 1944.
Tells of the different types of pilots, such as airline pilots, fighter-pilots, and bomber pilots, each one knowing his own plane and its specialty. Illustrated with photographs.
(6-8)

Lindbergh, Charles, We, G. P. Putnam's Sons, New York, 1927.
His own story of his famous flight across the Ocean.
(6-8)

Biography

Adams, Jean, Margaret Himbal, and Jeanette, Eaton, Heroines of The Sky, Doubleday Doran Company, Inc., Garden City, New York, 1942.
Stories of the most outstanding female pilots and their achievements. Illustrated.
(7-9)

Fraser, Chelsea, Famous American Flyers, Thomas Y. Crowell Company, New York, 1941.
Biographies of famous flyers, arranged chronologically. Shows the human side as well as the professional side.
(7-9)

Putnam, George P., Soaring Wings, Harcourt, Brace and Company, New York, 1939.
An informal biography of the great aviatrix, written by her husband.

General

Dalgliesh, Alice, illustrated by Katherine Milhouse. Wings Around South America, Charles Scribner's Sons, New York, 1941. $2.50.
Author and artist made trip around South America by airplane. A blend of travel material, personal anecdote, historical and biographical facts.
(5-8)

Floherty, John J., Board the Airliners, Doubleday Doran Company, 1934. $2.00.
A camera trip with the transport planes. Illustrated with photographs.
(4-6)

Gann, Ernest K., Sky Roads, Thomas Y. Crowell Company, New York, 1940. $2.00.
Gives good description of work of the airlines, the training of pilots, the weather and airline flight. Illustrated with maps and charts.
(6-9)

Lloyd, Trevor, Sky Highways, Houghton Mifflin Company, Boston, 1945. $2.00.
An airplane trip from Washington, D. C. to Chungking and back. Describes how air routes are selected, maps are plotted and passengers prepare for flight. Illustrated with pictures, diagrams, charts and maps.
(5-7)

Whipple, Gertrude, Airplanes at Work, The Macmillan Company, New York, 1944. $1.00.
Story of the many jobs that airplanes do in both wartime and peacetime. Illustrated with half tones and diagrams.
(Aviation Readers Series - 4)

Wooton, Frank, How to Draw Planes, The Studio Press, New York, 1941.
Useful in teaching how to draw a plane, shows perspective, light and shade, and cloud composition.

Model Building

Allen, Elmer L., New Model Airplanes, Frederick Stokes Company, Philadelphia, 1937. $3.00.
How to build and fly them.

General

Daglish, Alice. Illustrated by Katherine Milhous.
Vikings Around South America. Charles Scribner's
Sons. New York. 1941. $2.50.
Author and artist made trip around South America
by airplane. A blend of travel material, personal
anecdote, historical and biographical facts.
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Flaherty, John J.. Aboard the Airliners. Doubleday Doran
Company. 1934. $2.00.
A camera trip with the transport planes.
Illustrated with photographs.
(4-6)

Gann, Ernest K.. Sky Roads. Thomas Y. Crowell Company.
New York. 1940. $2.00.
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New York. 1941.
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Allen, Elmer L.. New Model Airplanes. Frederick Stokes
Company. Philadelphia. 1937. $3.00.
How to build and fly them.

Air Youth of America, Building and Flying Model Airplanes; An Air Youth Handbook, Century Company, Inc., New York, 1941.
A complete discussion of construction procedures. Well illustrated. Intended for use by both teacher and children.

Boy Scouts of America, Kites and Kite Flying, New York, 1931.
A manual of kite construction and kite flying which also presents the history of kites. Encourages reader to develop kites along original lines.

Collins, Francis A., The Boy's Book of Model Airplanes, D. Appleton-Century Company, New York, 1941.
Illustrated with photographs and diagrams. Introduction to the elements of model airplanes, and preparation to master the art of model building and flying from the ground up.

Cooke, David C., and Jesse Davidson, Model Plane Annual 1943, Robert McBride and Company, New York, 1943.
Photographs of model planes. Diagrams for building solid scale models.

Gilmore, H. H., Model Planes for Beginners, Harper and Brothers, New York, 1942. $1.25.
Explains how to make simplified models of real planes. Models are solid models. Tools and materials needed and instructions. Illustrated.

Graham, Frederick P., and Reginald M. Cleveland, Model Plane Annual 1941-1942, Robert McBride and Company, New York, 1941.
Devoted mainly to photographs of model planes and contests. One chapter lists rules for contest.

Hamilton, Edwin T., Complete Model Aircraft Manual, Dodd, Mead and Company, New York, 1938.
An excellent all-round book on materials, tools, and the making of model planes. Illustrated freely with diagrams.

Love, Edwin M., Junior Planes, Albert Whitman and Company, Chicago, 1933. $1.00.
Directions for building model planes which fly. Good for beginners. Illustrated.

Powell, James D., Junior Model Planes, Thomas Y. Crowell Company, New York, 1945.
Presents building and flying of model airplanes in a unique way.

Magazines

Aero Digest, Aeronautical Digest Publishing Company, 515 Madison Avenue, New York, Monthly. $3.00.
Covers the field of aviation in comprehensive style. Includes articles of general interest on commercial, military, and private aviation. Covers current news in the entire field. Excellent illustrations.

Air News, Air News Publishing Company, 545 Fifth Avenue New York, Monthly. $1.50.
A picture magazine of current events in aviation.

Air Progress, Street and Smith, 79 Seventh Avenue, New York, Quarterly. $1.25.
A magazine for the non-technical reader interested in aviation. Excellent full-page color photographs of recent planes.

Air Trails; the Model Builder's Guide, Street and Smith, 79 Seventh Avenue, New York, Monthly. $1.50.
A magazine for youth interested in model airplanes. Contains articles and plans for models. Includes articles and pictures of general interest in aviation.

Current Aviation, American Education Press, Inc., 400 South Front Street, Columbus, Ohio, and 690 Fifth Avenue, New York. Weekly during the school year. $.70.
A magazine for students of all grades, containing up-to-the-minute information concerning current developments in aviation.

Model Airplane News, Jay Publishing Corporation., Mt. Morris, Illinois. Monthly. $2.00.
A magazine for the young model builder. Each issue contains descriptions of new models and plans for making them. Usually includes articles on new plane types.

Model Aviation, (including Air Youth Horizons), Air Youth Division of the National Aeronautic Association, 1025 Connecticut Avenue, N.W., Washington, D. C. Apply.
Contains news and information of interest to young plane builders. Includes plans for model construction.

Magazines

The Official Aviation Guide of the Airways, The Official Aviation Guide Company, Inc., 608 South Dearborn Street, Chicago, Illinois. Monthly. $5.00 a year, $.50 a copy.
Contains time tables and passenger fares for air travel here and abroad.

Model Airplane Equipment

Best-By-Test Model Company, 176 Main Street, Ridgefield Park, N. J.

Commet Model Airplane and Supply Company, 1170 Broadway, New York.

Hobby Model Manufacturing Company, 149 W. 24th Street, New York.

Junior Aeronautical Association, 203 E. 15th Street, New York.

Annotated Films

Aerodynamics; Problem of Flight, Erpi Classroom Films, 1841 Broadway, New York, 1941, 11 min. - 16 mm, 35mm. Photography, diagrams, sound, commentary excellent. Study guide available. Film shows how an airplane pilot determines the movements of an airplane (taking off, climbing, banking, stalling, spinning, and recovery, diving, gliding, landing) by operating the plane's controls (rudder, elevators, ailerons, stabilizer fin), and demonstrates how these controls regulate the forces acting upon the plane in flight. Should follow Aerodynamics; Theory of Flight.

Aerodynamics; Theory of Flight, Erpi Classroom Films, 1841 Broadway, New York, 1941, 11 min. - 16 mm, 35 mm. Photography, diagrams, sound, commentary excellent. Study guide available. The film gives a general idea of the basic principles of aerodynamics by explaining and illustrating, with straight photography and animated diagrams of plain and cambered airfoils in a smoke tunnel, the lift and drag forces affecting a plane in flight. The motions of a plane caused by these forces, and the method of controlling a plane about vertical, lateral, and longitudinal axes with the rudder, elevator, and ailerons is demonstrated. Animation, superimposed on scenes of a model plane in flight, gives a graphic illustration of pitching, rolling, and yawing.

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Best-By-Test Model Company, 176 Main Street, Ridgefield Park, N. J.

Gimbel Model Airplane and Supply Company, 1170 Broadway, New York.

Hobby Model Manufacturing Company, 149 W. 24th Street, New York.

Junior Aeronautical Association, 203 E. 18th Street, New York.

Animated Films

Aerodynamics: Problem of Flight. Erpi Classroom Films, 1841 Broadway, New York, 1941. 11 min. - 16 mm. 35mm. Photography, diagrams, sound, commentary excellent. Study guide available. Film shows how an airplane pilot determines the movements of an airplane (taking off, climbing, banking, stalling, spinning, and recovery, diving, gliding, landing) by operating the plane's controls (rudder, elevators, ailerons, stabilizer fin), and demonstrates how these controls regulate the forces acting upon the plane in flight. Should follow Aerodynamics; Theory of Flight.

Aerodynamics: Theory of Flight. Erpi Classroom Films, 1841 Broadway, New York, 1941. 11 min. - 16 mm. 35 mm. Photography, diagrams, sound, commentary excellent. Study guide available. The film gives a general idea of the basic principles of aerodynamics by explaining and illustrating, with straight photography and animated diagrams of plain and cambered airfoils in a smoke tunnel, the lift and drag forces affecting a plane in flight. The motions of a plane caused by these forces, and the method of controlling a plane about vertical, lateral, and longitudinal axes with the rudder, elevator, and ailerons is demonstrated. Animation, superimposed on scenes of a model plane in flight, gives a graphic illustration of pitching, rolling, and yawing.

Air Currents and How They Behave, Pathe News, Visual Education Service, 131 Clarendon Street, Boston, Mass. 12 min - 16 mm. Excellent diagrams. Photography and sound fair. Part I. Clarence Chamberlin explains a device for observing and photographing air currents. Obstacles are suspended in the wind tunnel to show the action of air currents flowing past surfaces with different shapes. Miniature airplane wing in tunnel illustrates forces which keep an airplane in the air and which cause a plane to stall and to go into a tailspin.

America Learns to Fly, National Dairy Council, 111 North Canal Street, Chicago. 10 min - 16 mm. Photography, sound, commentary good. Air cadets maintain physical fitness, which means perfect coordination and steady nerves, by eating plenty of vegetables and milk products. Cadets are shown stages of flight instruction, and during recreation periods: examples to all Americans to keep physically fit for wartime efficiency. A new and timely approach to aviation.

Birds on the Wing, Edited Pictures System, 330 West 42nd Street, New York, 12 min - 16 mm, silent. Photography good, excellent slow-motion scenes. The film explains and illustrates, with the slow-motion camera, the methods of flight of pigeons, gulls, owls, condors, and hawks. It stresses the flight of gulls, the most efficient flying machines. Excellent demonstrations of natural flight.

Bray Aviation Series: Methods of Flight. Bray Picture Corporation, 729 Seventh Avenue, New York. 25 min - Sound - 16 mm. Photography good. Excellent slow-motion scenes of bird flights. The film shows how man has attempted to copy the methods of flight of birds. Slow-motion studies illustrate how birds move their wing and tail feathers in flight and upon landing. Man's attempt to copy flapping wing flight shown by the ornithopter. Soaring and gliding birds are pictured with scenes of man's more successful imitations - the sail plane and the glider. Lighter-than-air balloons are shown and examples of aircraft built on the rotating wing principle of the maple seed and the boomerang - the autogiro and the helicopter.

Clouds, United States Department of Agriculture, Office of Motion Pictures, Washington, D. C., 15 min - sound - 16 mm, 35 mm. Excellent photography. Harp music accompanies the film. The film touches on the beauty of clouds and explains briefly how clouds are formed and how they foreshadow changes in weather, making a knowledge of them essential to weather forecasting. The progression of different types of clouds in a typical cyclone wave is pictured with accompanying information on wind shifts, temperature changes, pressure changes, and average rate of travel of the wave. The pace of the film is rapid. The commentary identifies more than instructs. Film can be reshown with benefit for instructional purposes, for the photography is worth seeing more than once.

Clouds and Weather, is a ten-minute film made up of materials from Clouds, edited by The American Film Center. The sequences on the beauty of clouds have been omitted.

Clouds Go to Work, Edited Pictures Systems, 330 West 42nd Street, New York, 12 min - sound - 16 mm. Photography and commentary good. The film explains briefly how clouds are formed and the causes of the rain are shown: for power generation, irrigation, refrigeration, and drinking water.

Cushioned Landings, Good Year Tire and Rubber Company, Akron, Ohio. Silent 35 mm or 16 mm, 15 minutes. This picture is particularly interesting and valuable to aviators, airplane schools, instructors, pilots and others to whom aeronautical science has an appeal. Many views were taken with the camera fastened far out on the wing of the plane and focused on the wheel for the best studies during takeoff, flights and landings.

One Point Landings, Good Year Tire and Rubber Company, Akron, Ohio. Silent 35 mm or 16 mm, 15 minutes. This picture is one of the most unusual and unorthodox records ever made of airplane landing and takeoff performances. The performer is an airplane equipped with airwheels, great balloon tires, so large that the wheel disappears, leaving only axle and tire. Thus shod, the plane makes breath-taking landings first on one wheel, then on the other, then travels alternately on the right and left wheels.

Clouds. United States Department of Agriculture, Office of Motion Pictures, Washington, D. C. 15 min - sound - 16 mm. 55 rm. Excellent photography. Harp music accompanies the film. The film touches on the beauty of clouds and explains briefly how clouds are formed and how they foreshadow changes in weather, making a knowledge of them essential to weather forecasting. The progression of different types of clouds in a typical cyclone wave is pictured with accompanying information on wind shifts, temperature changes, pressure changes, and average rate of travel of the wave. The mood of the film is tragic. The commentary identifies more than instructs. Film can be teamed with benefit for instructional purposes. For the photography is worth seeing more than once.

Clouds and Weather. is a ten-minute film made up of materials from Clouds, edited by The American Film Center. The sequences on the beauty of clouds have been omitted.

Clouds Go to Work. United Pictures Systems, 330 West 42nd street, New York. 12 min - sound - 16 mm. Photography and commentary good. The film explains briefly how clouds are formed and the causes of the rain are shown: for power generation, irrigation, refrigeration, and drinking water.

Cushioned Landings. Good Year Tire and Rubber Company, Akron, Ohio. Silent 35 mm or 16 mm. 15 minutes. This picture is particularly interesting and valuable to aviators, airplane schools, instructors, pilots and others to whom aeronautical science has an appeal. Many views were taken with the camera fastened far out on the wing of the plane and focused on the wheel for the best studies during takeoff, flights and landings.

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Principles of Flight, Eastman Kodak Company, Rochester, New York, 15 min, silent, 16 mm. Photography, diagrams good. The film demonstrates, by scenes of gliders and kites, how air currents provide the lift forces which keep an airplane in the air. It explains, with diagrams, how streamlining cuts down the forces of resistance, and how, by operation of the plane's controls (rudder, elevators, ailerons, stabilizer, fin) movements of a plane in flight are regulated.

The Power of Clouds, A silent version of Clouds Go To Work, does not show so many uses of rain water but includes the other material in the sound film.

The Story of the Airship, Good Year Tire and Rubber Company, Akron, Ohio. 35 mm or 16 mm silent, 15 minutes. Shows developments from free balloon to giant aircraft. It depicts vividly the book by the same name written by Hugh Allen. It shows the beginning of American balloon-making and flying, the development of small airships (blimps) for student training, experimental and commercial purposes of the huge rigid airships, and finally the construction of the U. S. S. Macon, largest airship in the world, completed in April, 1933.

The Story of a Disturbance, Gaumont British Pictures Corporation of America, 12 min, sound, 16 mm. College Film Center, 59 E. Van Buren Center, Chicago. Photography and diagrams excellent. Use of speed-up camera to show cloud movements. Instruments used in the gathering of weather data and weather maps are explained. Diagrams show the progression of a disturbance across the face of the British Isles, the collision of the tropical air with the arctic air, the development of the cyclonic wave, and the occlusion process as the cold front overtakes the warm front. The types of clouds which accompany a disturbance are described, while the speed-up camera affords a remarkably effective means of studying their movements, which show the movements of air currents in such a disturbance.

Weather Forecasting, Eastman Kodak Company, Rochester, New York, 15 min, silent, 16 mm. Photography fair, diagrams fair. How weather observations are gathered, how these observations are recorded

on a weather map, and how the maps are interpreted by those who forecast the weather are the subjects of this film. Weather instruments are pictured, and their general use is noted but not explained thoroughly. Diagrams record a typical progression of high and low pressure areas across a map of the United States, while the application of such a progression to weather forecasting is indicated in the commentary.

Modern Weather Theory and Structure of Storms: Primary Circulation, and Development and Characteristics of Atmospheric Waves. Films No. 1-133 and 1-134.1/ Castle Films, 30 Rockefeller Plaza, New York. The purpose of these films is to give the student enough basic information to associate normal atmospheric occurrences with principles of weather theory.

Primary Circulation: Explains with the use of animated diagrams, the action of the earth's atmosphere: how the rotation of the earth modifies the circulation of the atmosphere; why surface winds are deflected to the right in the northern hemisphere, causing the northeast trade winds, deflected to the left in the southern hemisphere, causing the southeast trade winds; why air from the region around the equator rises and forms the southwest winds in the northern hemisphere and the northwest winds in the southern hemisphere; the causes of high pressure areas; the zone of prevailing westerlies; areas of heavy tropical rainfall; the evolution of cold, dry northeast winds; the formation of the polar front.

Development and Characteristics of Atmospheric Waves: Explains, with the use of animated diagrams, what a "source region" is and how it affects the atmosphere; the formation of low pressure areas; what the terms "cold front" and "warm front" mean; how a cold front underruns a warm front, causing a "passive uprise"; how a warm front overruns a cold front, causing an "active uprise"; the progress of a typical

1/ Produced by the U. S. Army Signal Corps. Through the courtesy of the War Department these have been released to the U. S. Office of Education for distribution to schools. The U. S. Office of Education will release these pictures through Castle Films.

atmospheric wave across the continent; the kinds of clouds that are formed; the possibility of precipitation; what an occluded front is and its effect upon the weather.

CHAPTER IV

AN EVALUATION OF THE UNITS

Results of objective testing.-- The results of objective testing on both units were very satisfactory. The range on the pre-test for Unit I was 40 with an assumed mean of 69, and an arithmetical mean of 70.32. The standard deviation was 8.79. See Table 10 for computations.

Table 10. Calculation of the Mean and the Standard Deviation of Unit I Pre-Test Results

Raw scores in class intervals of three	(f) Frequencies	(d) Deviations	(fd) Product of columns (2) and (3)	(fd^2) Product of columns (3) and (4)
(1)	(2)	(3)	(4)	(5)
89 - 91	1	+7	+7	49
86 - 88	0	+6	+0	0
83 - 85	0	+5	+0	0
80 - 82	7	+4	+28	112
77 - 79	0	+3	+ 0	0
74 - 76	5	+2	+10	20
71 - 73	1	+1	+1	1
68 - 70	10	0	0	
65 - 67	2	-1	-2	2
62 - 64	0	-2	-0	0
59 - 61	6	-3	-18	54
56 - 58	0	-4	-0	0
53 - 55	1	-5	-5	25
50 - 52	1	-6	-6	36
Totals.....	34		+15	299

+15 ÷ 34 = +.44

+.44 x 3 = +1.32 (correction)

69
+ 1.32
70.32 Arithmetical Mean

+.44 x +.44 = .1936

299 ÷ 34 = 8.79

8.79 - .1936 = 8.5964

$\sqrt{8.5964} = 2.93$

2.93 x 3 = 8.79 = Standard Deviation

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Table 10. Calculation of the Mean and the Standard Deviation of Unit I Pre-Test Results

Raw scores in class intervals of three (1)	Frequencies (2)	Deviations (3)	Products of columns (2) and (3) (4)	(fd^2) Products of columns (3) and (4) (5)
89 - 91	1	+7	+7	49
86 - 88	0	+6	+0	0
83 - 85	0	+5	+0	0
80 - 82	7	+4	+28	112
77 - 79	0	+3	+0	0
74 - 76	5	+2	+10	20
71 - 73	1	+1	+1	1
68 - 70	10	0	0	
65 - 67	3	-1	-3	3
62 - 64	0	-2	-0	0
59 - 61	6	-3	-18	54
56 - 58	0	-4	-0	0
53 - 55	1	-5	-5	25
50 - 52	1	-6	-6	36
Totals.....	34		+15	299

+15 ÷ 34 = +.44

+.44 x 3 = +1.32 (correction)

+.44 x +.44 = .1936

299 ÷ 34 = 8.79

8.79 - .1936 = 8.5964

$\sqrt{8.5964} = 2.93$

2.93 x 3 = 8.79= Standard Deviation

59 ÷ 1.32

70.32 Arithmetical Mean

The Unit I final test results showed a range of 50, an assumed mean of 81, an arithmetical mean of 76.86, and a standard deviation of 12.81. Table 11. gives calculations.

Table 11. Calculation of the Mean and the Standard Deviation of Unit I Final Test Results

Raw scores in class intervals of three	(f) Frequencies	(d) Deviations	(fd) Product of columns (2) and (3)	(fd^2) Product of columns (3) and (4)
(1)	(2)	(3)	(4)	(5)
92 - 94	3	+4	+12	48
89 - 91	2	+3	+6	18
86 - 88	5	+2	+10	20
83 - 85	4	+1	+4	4
80 - 82	5	0	0	
77 - 79	2	-1	-2	2
74 - 76	2	-2	-4	8
71 - 73	2	-3	-6	18
68 - 70	2	-4	-8	32
65 - 67	0	-5	-0	0
62 - 64	2	-6	-12	72
59 - 61	2	-7	-14	98
56 - 58	0	-8	-0	0
53 - 55	0	-9	-0	0
50 - 52	1	-10	-10	100
47 - 49	1	-11	-11	121
44 - 46	1	-12	-12	144
Totals	34		-47	685

$-47 \div 34 = -1.38$

$-1.38 \times 3 = 4.14$ (correction)

81
-4.14
76.86 Arithmetical Mean

$-1.38 \times -1.38 = -1.9044$

$685 \div 34 = 20.14$

$20.14 - 1.9044 = 18.24$

$\sqrt{18.24} = 4.27$

$4.27 \times 3 = 12.81 =$ Standard Deviation

The Unit I Final test results showed a range of 80, an assumed mean of 81, an arithmetical mean of 76.86, and a standard deviation of 12.81. Table 11. gives calculations.

Table 11. Calculation of the Mean and the Standard Deviation of Unit I Final Test Results

Raw scores in class intervals of three	(f) Frequencies	(d) Deviations	(fd) Product of columns (2) and (3)	(fd²) Product of columns (3) and (4)
(1)	(2)	(3)	(4)	(5)
92 - 94	3	+4	+12	48
89 - 91	2	+3	+6	18
86 - 88	5	+2	+10	20
83 - 85	4	+1	+4	4
80 - 82	5	0	0	
77 - 79	3	-1	-3	3
74 - 76	2	-2	-4	8
71 - 73	3	-3	-9	18
68 - 70	3	-4	-8	32
65 - 67	0	-5	-0	0
62 - 64	3	-6	-18	72
59 - 61	2	-7	-14	98
56 - 58	0	-8	-0	0
53 - 55	0	-9	-0	0
50 - 52	1	-10	-10	100
47 - 49	1	-11	-11	121
44 - 46	1	-12	-12	144
Totals	34		-47	685

$-47 \div 34 = -1.38$ — 81

$-1.38 \times 5 = 4.14$ (correction) — $\frac{-4.14}{76.86}$ Arithmetical mean

$-1.38 \times -1.38 = -1.9044$

$685 \div 34 = 20.14$ — $\sqrt{\quad} \quad 16.24 = 4.27$

$20.14 - 1.9044 = 18.24$ — $4.27 \times 3 = 12.81 =$

Standard Deviation

The range of scores on the mid-unit test for Unit II was 38, the assumed mean was 71, the arithmetical mean was 70.73, and the standard deviation was 9.69. See Table 12 for calculations.

Table 12. Calculation of the Mean and the Standard Deviation of Unit II Mid-Unit Test Results

Raw scores in class intervals of three	(f) Frequencies	(d) Deviations	(fd) Product of columns (2) and (3)	(fd^2) Product of columns (3) and (4)
(1)	(2)	(3)	(4)	(5)
86 - 88	3	+5	+15	75
83 - 85	1	+4	+4	16
80 - 82	6	+3	+18	54
76 - 79	2	+2	+4	8
73 - 75	2	+1	+2	2
70 - 72	7	0	0	
67 - 69	2	-1	-2	2
64 - 66	2	-2	-4	8
61 - 63	2	-3	-6	18
58 - 60	4	-4	-16	64
55 - 57	1	-5	-5	25
52 - 54	1	-6	-6	36
49 - 51	1	-7	-7	49
Totals	34		-3	357

-3 ÷ 34 = -.09

-.09 x 3 = .27 (Correction)

71
-.27
70.73 Arithmetical Mean

-.09 x -.09 = .0081

357 ÷ 34 = 10.50

10.50 - .0081 = 10.4919

$\sqrt{10.4919} = 3.23$

3.23 x 3 = 9.69 = Standard Deviation

The range of scores on the mid-unit test for Unit II was 38, the assumed mean was 71, the arithmetical mean was 70.73, and the standard deviation was 9.89. See Table 12 for calculations.

Table 12. Calculation of the Mean and the standard Deviation of Unit II Mid-Unit Test Results

Raw scores in class intervals of three (1)	Frequencies (2)	Deviations (3)	(2d) Product of columns (2) and (3)	(fd^2) Product of columns (3) and (4)
88 - 86	3	+5	+15	75
85 - 83	1	+4	+4	16
82 - 80	6	+3	+18	54
79 - 77	2	+2	+4	8
76 - 74	2	+1	+2	2
73 - 71	7	0		
70 - 68	2	-1	-2	2
67 - 65	2	-2	-4	8
64 - 62	2	-3	-6	18
61 - 59	4	-4	-16	64
58 - 56	1	-5	-5	25
55 - 53	1	-6	-6	36
52 - 50	1	-7	-7	49
Totals	34		-3	357

$-3 \div 34 = -.09$

$-.09 \times 3 = -.27$ (Correction)

$\frac{71}{-.27}$ 70.73 Arithmetical Mean

$-.09 \times -.09 = .0081$

$357 \div 34 = 10.50$

$10.50 - .0081 = 10.4919$

$\sqrt{10.4919} = 3.23$

$3.23 \times 3 = 9.69$ = Standard Deviation

On the final test of Unit II there was a range of 38, an assumed mean of 75, an arithmetical mean of 73.05 and a standard deviation of 9.45. See Table 13 for calculations.

Table 13. Calculation of the Mean and the Standard Deviation of Unit II Final Test Results

Raw scores in class intervals of three	(f) Frequencies	(d) Deviations	(fd) Product of columns (2) and (3)	(fd^2) Product of columns (3) and (4)
(1)	(2)	(3)	(4)	(5)
92 - 94	3	+5	+15	75
89 - 91	0	+4	+0	0
86 - 88	2	+3	+6	18
83 - 85	4	+2	+8	16
80 - 82	2	+1	+2	2
76 - 79	7	0	0	
73 - 75	4	-1	-4	4
70 - 72	1	-2	-2	4
66 - 69	7	-3	-21	63
63 - 65	0	-4	-0	0
60 - 62	0	-5	-0	0
57 - 59	2	-6	-12	72
54 - 56	2	-7	-14	98
Totals.....	34		-22	352

-22 ÷ 34 = .65

-.65 x 3 = -1.95 (correction)

75
-1.95
73.05 Arithmetical Mean

-.65 x -.65 = .4225

352 ÷ 34 = 10.35

10.35 - .4225 = 9.9275

$\sqrt{9.9275} = 3.15$

3.15 x 3 = 9.45 = Standard Deviation

On the final test of Unit II there was a range of 58, an assumed mean of 75, an arithmetical mean of 73.05 and a standard deviation of 9.45. See Table 15 for calculations.

Table 15. Calculation of the Mean and the Standard Deviation of Unit II Final Test Results

Raw scores in class intervals of three (1)	Frequencies (2)	Deviations (3)	(2d) Product of columns (2) and (3)	($2d^2$) Product of columns (3) and (4)
93 - 94	3	+5	+15	75
89 - 91	0	+4	+0	0
86 - 88	2	+3	+6	18
83 - 85	4	+2	+8	16
80 - 82	2	+1	+2	2
76 - 79	7	0	0	
73 - 75	4	-1	-4	4
70 - 72	1	-2	-2	4
66 - 69	7	-3	-21	63
63 - 65	0	-4	-0	0
60 - 62	0	-5	-0	0
57 - 59	2	-6	-12	72
54 - 56	2	-7	-14	98
Totals.....	34		-22	352

$-22 \div 34 = -.65$

$-.65 \times 3 = -1.95$ (correction)

$\frac{76}{-1.95}$ 73.05 Arithmetical Mean

$-.65 \times -.65 = .4225$

$352 \div 34 = 10.35$

$\sqrt{\quad .9275} = 3.15$

$10.35 - .4225 = 9.9275$

$3.15 \times 3 = 9.45$ = Standard Deviation.

Relative growth of pupils.-- Knowing the pupil's actual growth is not sufficient; it is well to know his relative growth. In educational planning it is helpful to know how a pupil's actual growth compares with the growth made by the others in the group and with the average growth of the class.

Using the calculated means and standard deviations, relative growth scales were constructed. Group I represents pupils of superior achievement; Group II, those who are decidedly above the average of the group; Group III, those whose growth is average; Group IV, those whose growth is inferior. Figures 12 to 15 below and on the following pages show the actual distributions of pupil growth for the tests and points gained.

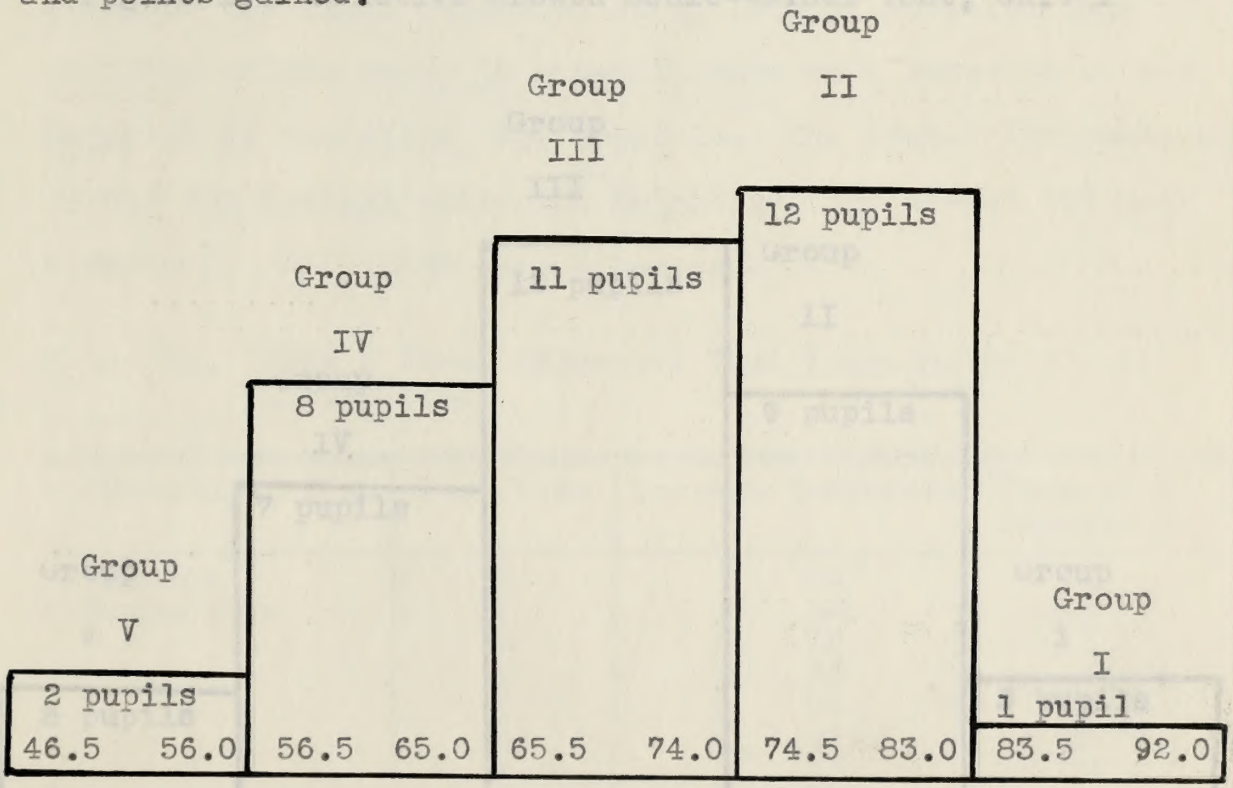

Figure 12. Relative Growth Scale--Pre-test, Unit I

Figure 12. Relative Growth Scale--Pre-test, Unit I

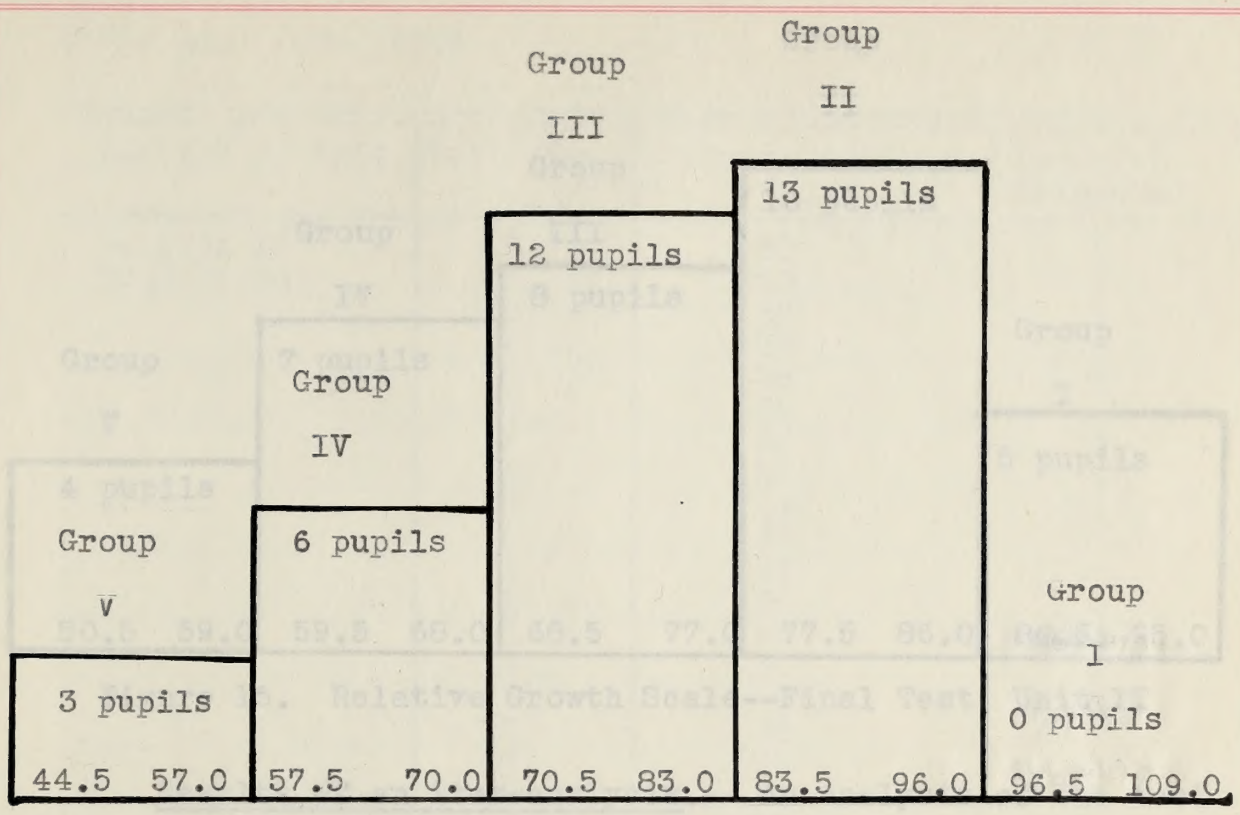

Figure 13. Relative Growth Scale--Final Test, Unit I

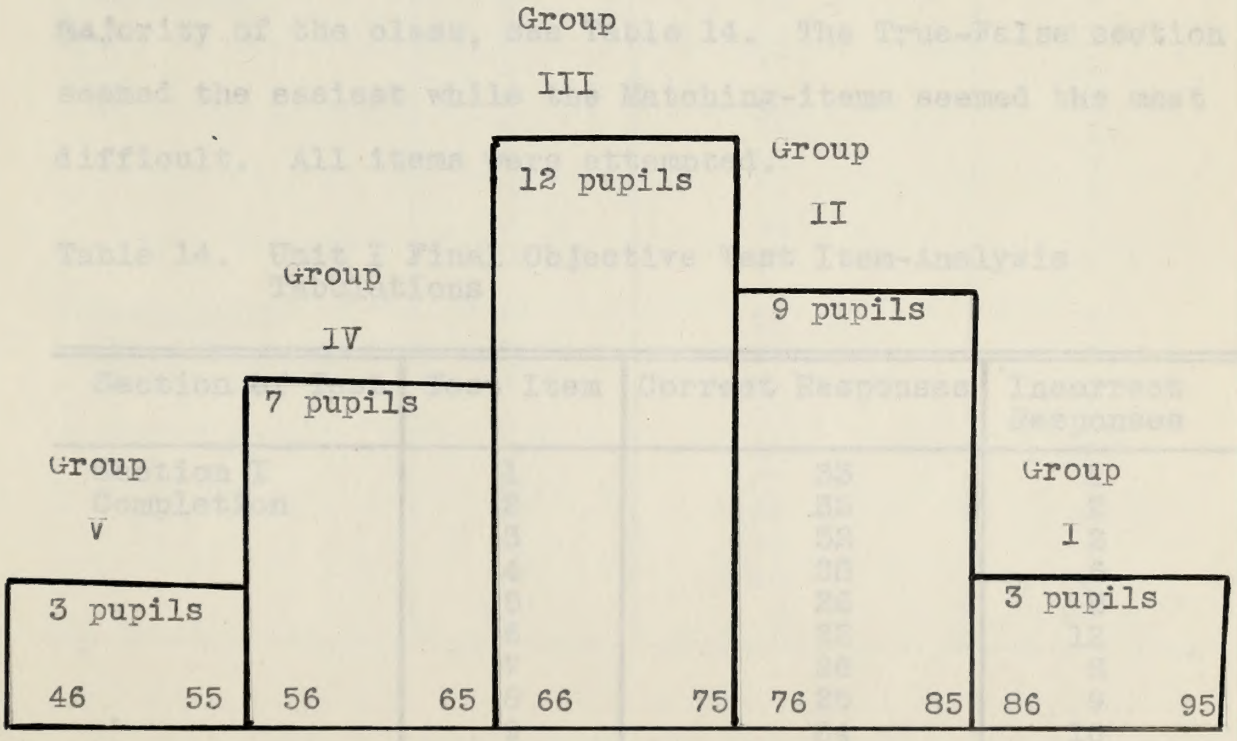

Figure 14. Relative Growth Scale--Mid-test, Unit II

Figure 13. Relative growth scale--final test, Unit I

Figure 14. Relative growth Scale--Mid-test, Unit II

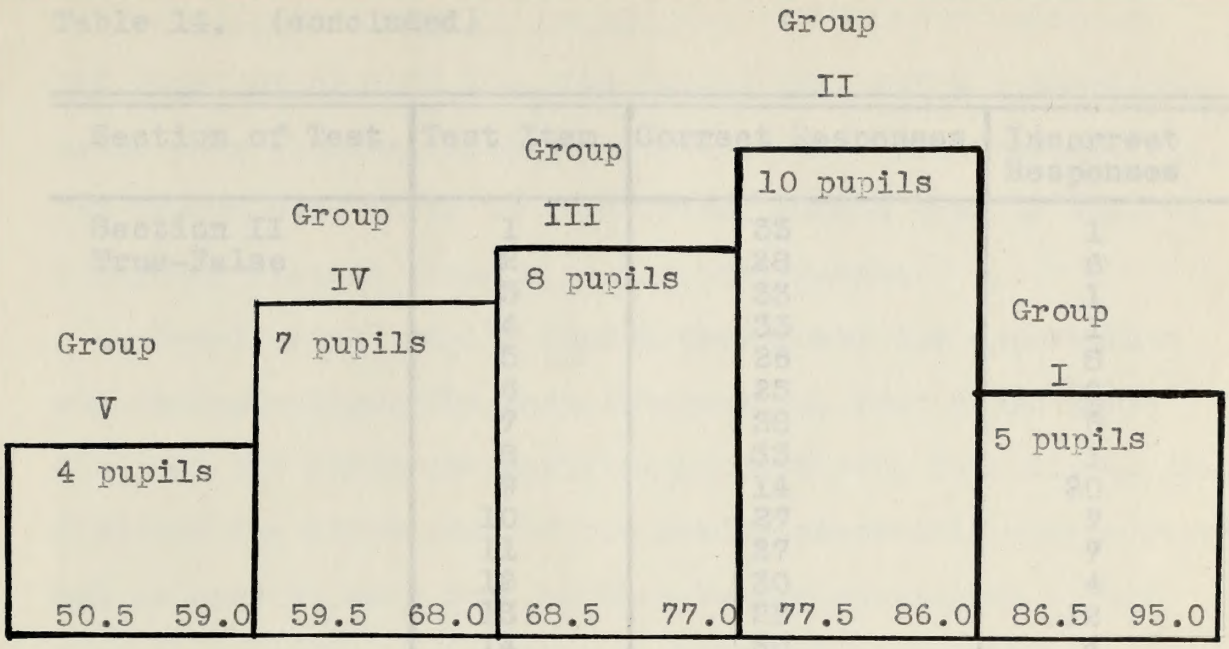

Figure 15. Relative Growth Scale--Final Test, Unit II

Results of an item-analysis.-- An analysis of the test items of the final objective test, Unit I, revealed that all sections of the test, in general, were well answered by the majority of the class, see Table 14. The True-False section seemed the easiest while the Matching-items seemed the most difficult. All items were attempted.

Table 14. Unit I Final Objective Test Item-Analysis Tabulations

Section of Test	Test Item	Correct Responses	Incorrect Responses
Section I Completion	1	33	1
	2	32	2
	3	32	2
	4	28	6
	5	26	8
	6	22	12
	7	26	8
	8	25	9
	9	24	10
	10	29	5

Figure 15. Relative Growth Scale--Final Test, Unit II

Results of an item-analysis.-- An analysis of the test items of the final objective test, Unit I, revealed that all sections of the test, in general, were well answered by the majority of the class, see Table 14. The True-False section seemed the easiest while the Matching-items seemed the most difficult. All items were attempted.

Table 14. Unit I Final Objective Test Item-Analysis Tabulations

Section of Test	Test Item	Correct Responses	Incorrect Responses
Section I Completion	1	38	1
	2	32	2
	3	32	2
	4	28	6
	5	26	8
	6	22	12
	7	28	6
	8	25	9
	9	24	10
	10	29	5

Table 14. (concluded)

Section of Test	Test Item	Correct Responses	Incorrect Responses
Section II True-False	1	33	1
	2	28	6
	3	33	1
	4	33	1
	5	26	8
	6	25	9
	7	28	6
	8	33	1
	9	14	20
	10	27	7
	11	27	7
	12	30	4
	13	22	12
	14	30	4
	15	30	4
	16	25	9
	17	32	2
	18	30	4
	19	15	19
	20	23	11
Section III Matching	1	23	11
	2	25	9
	3	19	15
	4	27	7
	5	21	13
	6	31	3
	7	25	9
	8	17	17
	9	30	4
	10	27	7
Section IV Choosing correct statement	1	31	3
	2	27	7
	3	15	19
	4	33	1
	5	21	13
	6	25	9
	7	32	2
	8	28	6
	9	26	8
	10	4	30

Table 14. (concluded)

Section of Test	Test Item	Correct Response	Incorrect Response
Section II	1	33	1
True-false	2	28	6
	3	33	1
	4	33	1
	5	26	8
	6	25	9
	7	26	6
	8	33	1
	9	14	20
	10	27	7
	11	27	7
	12	30	4
	13	22	12
	14	30	4
	15	30	4
	16	25	9
	17	32	2
	18	30	4
	19	15	19
	20	20	11
Section III	1	32	11
Matching	2	25	9
	3	10	15
	4	27	7
	5	21	13
	6	31	3
	7	25	9
	8	17	17
	9	30	4
	10	27	7
Section IV	1	31	3
Choosing correct	2	27	7
statement	3	15	19
	4	33	1
	5	21	13
	6	25	9
	7	32	2
	8	28	6
	9	26	8
	10	4	30

Pupil-reactions to the unit.-- At the conclusion of the study of Air and You, the pupils were given a questionnaire (see Chapter II, page 67) to be answered subjectively. The pupils were asked to give frank, candid and, if desired anonymous answers concerning the unit-method.

Twenty-eight pupils stated they found the experiments and demonstrations the most interesting, four stated they disliked the study-and-activity-guide sheet, four stated they disliked the first part of the study-and-activity-guide sheet but enjoyed it very much as they became accustomed to the method, fourteen stated they enjoyed the study-and-activity-guide sheet because they liked to do research work, eleven liked the excursions, one pupil found the study boring, fifteen stated their fondness for some specific topic in the unit, four found the method difficult, while seven found it easy, sixteen wrote their names to the blank.

One girl said, "I liked the way we had a chance to do experiments to prove our research". Another girl said, "I think the guide-sheet was a wonderful way to study about Air because it made it so interesting". A boy said, "I disliked it because of the lack of books but I really love research work". This last statement was made due to the fact that there wasn't enough of each of the supplementary books and the boy, upon being questioned regarding his statement, stated he couldn't always get the desired book just when he wanted it. Another boy said, "I found myself taking my guide-sheet home to do some extra work". An

anonymous pupil stated, "I liked the way the unit was organized but I will have to try harder so that I may get a higher mark on the tests". One boy said, "It was lots of fun".

Parental-reactions to the unit-method.-- A large number of the pupils' parents either visited school or telephoned during the course of the teaching of the unit to state their favorable opinions concerning the method. Most of the remarks were of a general nature and stating simply that their boy or girl was very enthused about the new method of study. However, the father of one problem boy, whose home has been broken on two occasions as a result of divorces and the child who is extremely insecure, and unpopular, said, "This is the first time that John has shown any interest openly to me about his school work. He likes to study by this method. He has taken books home and read them to find answers to the questions, and did many experiments in the hope of being chosen as a pupil-leader". The father later asked the teacher, "Could you give him a chance to perform one of the experiments so that his enthusiasm might be encouraged?" The boy was given this opportunity and certainly proved no problem at any time.

A Mrs. S. came to the school one day and had the principal call the teacher to the office. Upon arrival at the office Mrs. S. said, "I simply wanted to tell you in front of your principal what I think about the method

you have been teaching the unit on air. Raymond has kept all his papers, guide-sheet, tests and written work in an orderly fashion and showed me these. I looked them over carefully, then took them to show to a teacher in Lexington and she too thought it was wonderfully organized and would like copies of the unit plans. My son has brought home work every single day and we are happy over his enthusiasm".

These few comments probably speak as objectively as possible in regard to this method.

It should be mentioned that the policy of the school is not to give home-work to pupils unless they are retarded, have been absent, or they show a desire to do extra work and permission is requested. Throughout the unit the majority of the pupils requested and received permission to do extra work to encourage their strong enthusiasm.

Findings from the daily log.-- A log was kept during the entire time of the unit. Brief diary-form notes were written about the way in which the unit was progressing. Good as well as bad reports were entered into the log. Some of the highlights from the log kept about Unit I were as follows; The pupils were enthusiastic from the outset as revealed in the introductory period. During the laboratory period two main difficulties were encountered, one was the short period in which to work, and the other was that the pupils were somewhat at a loss when it came time to getting their materials ready for demonstration purposes. As a result of the short periods the introductory

activities were cut short or sometimes ommitted entirely. The pupils found books suitable to their own level of achievement. (see Plate 1) Many of them were not satisfied with the reference list but found extra help from the school's encyclopedias and books from their homes and the public library.

Plate 1. Two pupils making use of the library of both reference and related reading books

Most of the pupils brought pictures, clippings, toys, or bits of machinery pertinent to the study. These were either placed on the bulletin board or arranged for display by a pupil-committee. Demonstrations and experiments were done by the teacher, or oftentimes by elected pupil-leaders in front of the entire class, and occasionally by pupil-leaders in front of small groups. (see Plate 2)

Plate 2. A group of pupils doing core activity experiments in the teachers' room. The experiments are; the siphon, a lung, and water being replaced by air in order to flow

In all cases the pupils studied the demonstration questions and answered their findings after witnessing the experiment results. During the pooling-and-sharing phase the pupils were given ample time for their reports or experiments at first, but this was found to be consuming

too much time, consequently the time allowed each pupil was shortened.

Twenty-six of the thirty-four optional activities were selected. The activities selected were as follows:[1/]

#1, demonstrated by four pupil-leaders before small groups, #2, performed by a girl before the entire class, #3, #4, #5, #7, explained by a boy whose father worked in an ice-cream plant, #8, items were brought in by each one of the thirty-four pupils, #12, #13, #14, #16, done by two pupils, #17, reported by three boys, #18, #19, temperature reports kept by two girls and three boys, #20, demonstrated by four pupils, #21, demonstrated by three pupils, #22, constructed by six pupils, #24, #27, demonstrated by one boy and one girl, #28, #29, cloud-collections were made by five pupils, #30, #31, #32, scrapbooks of experiments and clippings were kept by each of the thirty-four pupils, #33, and #34.

They completed a total of thirty-nine activities. This was an addition to keeping an up-to-date science notebook which was checked weekly by the teacher in order to better determine the individual progress of each pupil.

The excursion to the hospital, to witness the uses of air proved interesting as well as educational. Unfortunately an iron-lung was not available for demonstration on our

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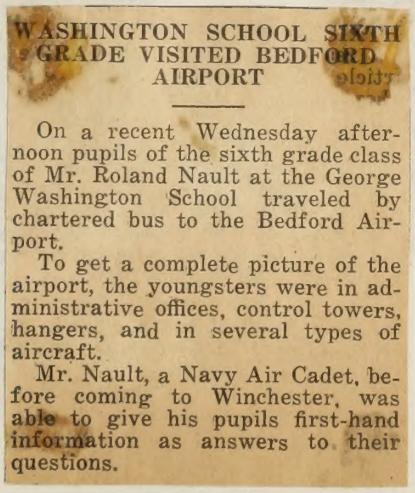
1/ The ensuing numbers are the number of optional activities described fully in Chapter II p. 56-59.

visiting days. The newspaper clippings below gives the details of the trips.

The last phase of the unit was the 50-question objective test. Signs were posted on the doors stating that testing was taking place and for nobody to disturb. The first pupil finished the test in fourteen minutes while the last one finished in an even thirty minutes.

Cooperation from the regular classroom teacher.-- The activities dealing with arithmetic, such as circle and bar-graphs, calculating the amount of air in the classroom, and the activities dealing with oral or written composition were done under the direction of the regular classroom teacher. This met with great approval as it offered motivation for those particular subjects. The following newspaper clippings which appeared in the local newspaper, are the result of English work written by the pupils and published during the course of the units.



WASHINGTON SCHOOL SIXTH GRADE VISITED BEDFORD AIRPORT

On a recent Wednesday afternoon pupils of the sixth grade class of Mr. Roland Nault at the George Washington School traveled by chartered bus to the Bedford Airport.

To get a complete picture of the airport, the youngsters were in administrative offices, control towers, hangers, and in several types of aircraft.

Mr. Nault, a Navy Air Cadet, before coming to Winchester, was able to give his pupils first-hand information as answers to their questions.

GEORGE WASHINGTON SCHOOL NEWS

Sixth grade pupils of the George Washington School have recently concluded their study of a unit called, "The Air We Breathe." In connection with this study, arrangements were made with Mr. Tucker Vye, Administrator of the Winchester Hospital, for an explanation of the workings of air and oxygen apparatus used in the hospital.

Mr. Roland A. Nault's class was divided into three groups. The groups went to a special room in the hospital on separate days and witnessed a lecture and practical demonstrations. Miss Patricia Daley, Supervisor of the Out-Patient Department, explained the use of the oxygen resuscitator and Miss Laura Rogers, Supervisor of Nurses, explained the oxygen tent, while Mr. Vye added interesting comments about the oxygen tanks. The pupils enjoyed the educational visits to the hospital and are grateful to the members of the staff for their fine cooperation with the school in this project.

GEORGE WASHINGTON SCHOOL NEWS

The boys of the fifth-grade have started playing a new game during recess and gym period. It is called speedball. This game is a combination of soccer and football.

The fifth-grade boys and girls have written letters to pen pals in British Honduras as part of their practical experience in language. Mrs. Harris, the mother of one of the pupils, mails the letters to our Pan-American neighbors.

The sixth-grade is finishing up a unit of research and experiments on "The Air We Breathe."

A large twenty-one foot mural is in progress in the school's upstairs corridor. The pupils are busily engaged in painting this forest scene for their Christmas Pageant.

WASHINGTON SCHOOL NOTES

The sixth-grade pupils are in the midst of another science unit. This one is called "Men Fly" and is the study, research, and demonstration of aviation topics. So far the pupils have covered the history of aviation, what makes a plane fly, and the parts of an airplane. Committees are at work on a model airport, and a ten foot-mural depicting the story of aviation. The committees are made up of Donald Turpin, Mathew Andrews, Leeta Berman, Sally Cunningham, Madeline Derro, and Sylvia Crowelli.

Report of the books read by pupils.-- A survey was made of the number of pupils who read books or stories listed in the classified-annotated-bibliography found at the end of Chapter III. The pupils submitted written reports on teacher-prepared forms of each book or story on aviation topics which they read during the course of the first semester and until the February vacation. Table 15 gives the list of books that were selected and the number of pupils who read the books or stories.

Table 15. Report of Books and Stories on Aviation Subjects Read by Pupils

Name of Book or Story	Number of Pupils Who Read Book or Story
Basal Readers:	
The Earth We Live On,	
The Giant Dragon Fly, p. 220-230	14
Our World and Others,	
First Dawn-to-Dusk Flight, p. 59-71	26
Let's Look Around,	
Playing Airplane, p. 340-361	4
A Famous Flight, p. 364-374	4
The Sky-Writer, p. 378-383	6
The Dirigible, p. 377	29
Flight, p. 385-386	4
Let's Go Ahead,	
Story of Orville and Wilbur Wright, p. 367-390	9
Tales and Travel,	
Flying Across the Pacific, p. 366-373	11
Dirigibles, p. 376-383	8
The Zeppelin, p. 375	11
Today and Tomorrow,	
We Go by Air, p. 277-312	3
Fun and Frolic,	
The First Balloon Ride, p. 172-179	7
The Brave and the Free,	
The Runaway Plane, p. 86-95	4
Sky High, p. 139	5

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The Giant Dragon Fly, p. 220-230	14
Our World and Others.	
First Down-to-Dusk Flight, p. 59-71	36
Let's Look Around.	
Flying Airplane, p. 340-361	4
A Famous Flight, p. 364-374	4
The Sky-Writer, p. 378-385	6
The Dirigible, p. 377	20
Flight, p. 386-396	4
Let's Go Ahead.	
Story of Orville and Wilbur Wright, p. 387-390	9
Tales and Travel.	
Flying Across the Pacific, p. 366-373	11
Dirigibles, p. 376-385	8
The Zeppelin, p. 375	11
Today and Tomorrow.	
We Go by Air, p. 277-312	3
Fun and Frolic.	
The First Balloon Ride, p. 172-179	7
The Brave and the Free.	
The Runaway Plane, p. 86-95	4
Sky High, p. 150	5

Table 15. (continued)

Name of Book or Story	Number of Pupils Who Read Book or Story
Basal Readers: (concluded)	
Engine Whistles, Headlines, p. 228-249	2
Exploring New Trails, Sky Navigators, p. 66-74	3
From Every Land, They Fly Through the Air, p. 265-266	8
Stories and Fiction:	
Sky Freighter,	1
Sky Blazer,	2
Skyways,	4
Flight 17,	12
Bob Wakefield; Naval Aviation,	1
Timmy Rides the China Clipper,	3
On The Airways,	2
Sky Ride,	5
The Dirigible Book,	9
Navy Wings of Gold,	1
Airplane Andy,	2
History:	
The Wonder Book of the Air,	6
The Man Who Gave Us Wings,	1
Wings For America,	1
Heroes of the Air,	5
The Story of Aircraft,	1
Famous American Flyers,	1
Flying Fleets,	17
Bamboo to Bombers,	1
Science:	
Aviation Science for Boys and Girls,	34
Elementary School Science for the Air Age	29
Science of Pre-Flight Aeronautics,	3
The Story of Flying,	1
The Earth Then and Now, Man Invents an Airplane, What Keeps an Airplane in the Air?, p. 420-427	24
Junior Aviation Science,	3
Flying and How to Do It,	9
Clouds, Rain and Snow, (booklet)	28
The Air About Us, (booklet)	13
Let's Fly: An A. B. C. of Flying	1
Book of Modern Warplanes,	7
War Wings,	1
Fighting Planes of the World,	3

Table 15. (concluded)

Name of Book or Story	Number of Pupils Who Read Book or Story
Career:	
Aeronautical Occupations,	2
Needed-Women in Aviation,	1
Sky Hostess,	1
When I Grow Up I'll Be a Flyer,	1
Keep 'Em Flying,	2
Aviators:	
That's My Story,	2
We,	2
Biography:	
Famous American Flyers,	1

Growth in skills and habits.-- In order to have a better understanding of the growth in skills and habits of each pupil during the course of the teaching of the two units, a chart listing the skills and habits to be developed was kept for each individual pupil. A check mark indicated those traits which needed to be attended to and also a brief anecdotal account of the improvement during the teaching of the units. The data for these pupil-charts was checked, at times, during the actual laboratory period or at the end of the day, whichever method seemed most feasible according to the circumstances. A sample copy of the chart used is on page 190 of Appendix A.

Behavior record.-- A record of the pupils' personality traits was kept during the teaching of the two units. The traits were listed in chart form, see page 191 of Appendix A. One column was used to check the personality

Table 15. (concluded)

Name of Book or Story	Number of Pupils Who Used Book or Story
Workers:	
Mechanical Occupations.	3
Model-Wrecks in Aviation.	1
Sky Lookers.	1
When I Grow Up I'll Be a Flyer.	1
Book of Flyers.	2
Aviators:	
Pete's Sky Story.	2
[illegible].	2
History:	
Famous American Flyers.	1

traits requiring attention and two columns were devoted to anecdotal accounts of the development of each trait during the course of the teaching of the two units.

Use of the skills and habits and behavior charts.-- Whenever a pupil was called back for a conference the record charts were taken out of the files and the pupil was told of teacher's findings listed on the charts. This afforded a basis for fair and tangible diagnosis of both the pupil's weak and strong points and the improvement or lack of improvement during the period under study. It was of great interest to notice how the pupils tended to look forward to the conference periods in order to be given his standing. The pupils were always anxious to return for another conference period in order to see if they had improved. No tabulations were made of the results of these skills, habits, and behavior charts but it was felt that in approximately ninety-percent of the cases studied, great improvements were made in the traits or items checked.

Results of an item-analysis.-- An analysis of the test items in the final objective test, Unit II, Men Fly, revealed that in general the test was difficult and challenging to all pupils. The twenty true-false items and the twelve matching items met with the best results. The five completion items were the most difficult, while the identification section came out with fair results, see Table 16. Thirty minutes were allowed for the test. All but four pupils required the full time allowed.

The form of the test will be revised in order to facilitate quicker scoring.

Table 16. Unit II Final Objective Test Item-Analysis Tabulations

Section of Test	Test Item	Correct Responses	Incorrect Responses	Items Omitted
Section A: True-False	1	33	1	0
	2	22	12	0
	3	28	6	0
	4	22	12	0
	5	29	5	0
	6	23	11	0
	7	22	12	0
	8	27	7	0
	9	24	9	1
	10	23	6	5
	11	25	5	4
	12	33	1	0
	13	17	17	0
	14	27	7	0
	15	27	6	1
	16	34	0	0
	17	20	12	2
	18	23	11	0
	19	28	6	0
	20	23	11	0
Section B: Completion	1	28	2	4
	2	13	11	10
	3	16	6	12
	4	26	1	7
	5	20	6	8
Section C: Matching	1	26	6	2
	2	32	1	1
	3	29	1	4
	4	28	5	1
	5	28	4	2
	6	25	7	2
	7	19	7	8
	8	11	21	2
	9	14	13	7
	10	13	16	5
	11	32	1	1
	12	27	3	4

Section of Test	Test Item	Correct Responses	Incorrect Responses	Items omitted
Section A: True-False	1	35	1	0
	2	28	12	0
	3	29	9	0
	4	32	12	0
	5	29	5	0
	6	25	11	0
	7	28	12	0
	8	27	7	0
	9	24	9	1
	10	29	6	3
	11	25	5	4
	12	33	1	0
	13	17	17	0
	14	27	7	0
	15	27	6	1
	16	34	0	0
	17	20	12	2
	18	23	11	0
	19	28	6	0
	20	23	11	0
Section B: Completion	1	28	2	4
	2	15	11	10
	3	16	6	12
	4	26	1	7
	5	20	6	8
Section C: Matching	1	26	6	2
	2	32	1	1
	3	30	1	4
	4	28	5	1
	5	30	4	2
	6	25	7	3
	7	30	7	0
	8	11	21	2
	9	14	15	7
	10	15	16	5
	11	30	1	1
	12	27	3	4

Table 16. (concluded)

Section of Test	Test Item	Correct Responses	Incorrect Responses	Items Omitted
Section D: Identification	1	28	5	1
	2	23	11	0
	3	18	11	5
	4	30	3	1
	5	30	2	2
	6	32	2	0
	7	25	6	3
	8	28	6	0
	9	20	11	3
	10	34	0	0
	11	18	11	5
	12	21	9	4

Pupil-reactions to the unit.-- At the conclusion of the study of the unit Men Fly, the pupils were given a questionnaire (see Chapter III, page 130) to be answered subjectively. The pupils were asked to give frank, candid, constructive, and if desired anonymous answers concerning the method employed in the study of aviation.

The majority of the pupils implied that they enjoyed the method better now that they had become accustomed to it. Six pupils still laid emphasis on the experiments and demonstrations. Sixteen stated they liked the history of aviation the best, all thirty-four stated they liked the optional related activities, although eight of them said they did not have sufficient time to get to the optional related activities. Twelve liked the model airport that was constructed in the class. Six liked making the notebooks and scrapbooks, while four others enjoyed preparing

Section of Test	Test Item	Correct Responses	Incorrect Responses	Items Omitted
Section D: Identification	1	38	6	1
	2	23	11	0
	3	19	11	5
	4	20	5	1
	5	30	2	3
	6	32	2	0
	7	25	6	3
	8	28	8	0
	9	20	11	3
	10	34	0	0
	11	18	11	5
	12	21	9	4

the assembly program. Eighteen wrote they liked the guide-sheet best. The lack of time was mentioned by seven and upon further questioning on this point, it was further revealed that they meant the periods were too short, and also that they didn't get a chance to complete the core activities in time enough to start on the optional related activities.

One girl stated, "I like to do the optional activities because it gives me a chance to get a better mark". Another girl wrote, "I think the optional activities are lots of fun and we will all get a lot out of them". Six liked to study about the parts of the airplane best. Two stated they liked the movies. Thirteen enjoyed keeping abreast of the aviation news via the bulletin board kept up to date by a pupil committee. (see Plate 3) Three stated they had trouble getting the particular reference book they wanted, just when they wanted it. One girl made a very constructive suggestion. She wrote, "Why couldn't the girls and boys be divided into two groups and let them choose their own topics. Some of the girls don't like to study about aviation". All but four of the questionnaires revealed that the pupils were definitely well pleased with the subject and the method of study. All but four signed their names to the questionnaire.

The daily log, Unit II.-- A log was kept during the entire teaching time of the unit on aviation. Daily notes

of the activities carried on by both teacher and pupils, progress, and other points pertinent to the study were written in the log. Some of the highlights from the log kept were as follows: The unit was introduced with the aid of a set of questions[1/] written on the board which were answered after the showing of the film, "The Airplane Changes the Map of the World". The picture was shown twice in order to clarify some of the questions. The second period was spent describing and discussing the comparative ways of traveling from Boston to Washington, D. C. The study-and-activity-guide sheet was given out along with the reference list. During the next five class periods the pupils did research work on their core activities. Introductory activities were cut short and consisted chiefly of current affairs in the aviation world. During the second week, while studying about the history of aviation, two 15-minute sound films entitled, "Balloons", and "Dirigibles" loaned to us by the Goodyear Company, were shown. The pupils were given a set of questions to answer outside of school after seeing the films. The remainder of the laboratory phase was spent with research (see Plate 3) and with experiments and demonstrations presented to the class by elected pupil-leaders. Occasional oral and written tests were given in order to determine pupil progress.

1/ Questions are listed in the introduction of the Unit Assignment, Chapter III p. 93-94.

IV Questions are listed in the introduction of the Unit Assignment, Chapter III p. 93-94.

Plate 3. Six pupils at work on various activities. The girl at the left is selecting an optional-related-activity, the boy in the center background is locating material to illustrate a report, while the group in the right foreground is at work with core activities from the study-and-guide sheet.

Another silent film entitled, "Cushioned Landings", by the Goodyear Company was shown. The pupils answered questions about the film. The pupils carried on their experiments much better in this unit. We discussed the field trip and passed out "A Trip to the Bedford Airport" questionnaire, see Appendix A. A day was required to make the trip via bus to the airport. The class was guided through all parts of the airport. The

Plate 3. Six pupils at work on various activities. The girl at the left is selecting an optional-related-activity, the boy in the center background is locating material to illustrate a report, while the group in the right foreground is at work with core activities from the study-and-guide sheet.

army section occupied most of the time. This trip remained a highlight of the unit as well as a good reference frequently used in oral discussions. All questionnaires were answered fully, scored, and returned for the pupils' notebooks. The language teacher used this trip as a language experience. The best report was sent in to the local newspaper for publication.

The notebooks were collected twice during the laboratory phase in order to get a picture of the progress. Many of the optional related activities were being carried on during the laboratory phase. A few of these were a large 12-foot mural depicting the story of aviation from the start to the present, an assembly program, a model airport (see Plate 4) and the bulletin board. (see Plate 5)

Plate 4. Three pupils, two of which are completing the model airport, and the third has plotted air-routes from Boston to all the leading foreign cities.

Plate 5. Three pupils mounting pictures, clippings, and original drawings on the classroom bulletin board especially constructed for these units.

Five periods were spent for the pooling-and-sharing phase. Two of these periods were given up to discussion of review nature, and reports and demonstrations from the optional related activities file. The last three periods were spent in the preparation and presentation of an all-school and invited-parents assembly, called "Men Fly". This was an original creation by a committee of three in the form of a play depicting the history of aviation with demonstrations carried on at various intervals to make the subjects more vivid. The program lasted twenty-five minutes.

Twenty-four of the sixty optional related activities

were selected. This was due to the fact that so much time was necessary to cover the core activities, and because of a number of days without school due to incliment weather. The unit was concluded with the start of the February 22 week's vacation.

The activities selected were as follows: three pupils serving on a bulletin board committee (see Plate 5), four pupils planned and painted a 12-foot mural in the school's corridor depicting the history of aviation, three pupils collected and mounted air mail stamps for display, thirty-four pupils read and reported on various books listed in the classified bibliography of Chapter III, six pupils made special scrapbooks, two made careful records of the weather for a period of two weeks, one constructed a model airplane, one pupil wrote his findings about early stratosphere flights, two made posters of flying hazards, three reported on magazine articles pertinent to the topics under study, one reported on the radio-beam operation, one made a collection of aviators' language, one made a slingshot glider, one pupil performed two aerodynamic demonstrations listed in #40, one pupil demonstrated the use of the compass, one pupil wrote up a report on a sextant and drew a picture of a instrument, one pupil reported on G.C.A. landings, one pupil planned an airplane trip as listed in #47, one pupil demonstrated a small home-made parachute, one pupil demonstrated the Cartesian

diver, one pupil made a large drawing of the layers of space above the earth, (see Plate 5) one pupil painted on oak-tagboard pictures of airplanes with moveable parts, one pupil made a toy helicopter, and one pupil reported on his trip to the New York airport. This is a good representation considering the fact that the time element was short.

The last phase of the teaching cycle was the 49-question objective achievement test. Signs, stating that testing was taking place, were posted on the classroom's three doors. At the conclusion of the entire unit the opinion questionnaire was given. The results of these findings are stated on previous pages in this chapter.

Future outlook.-- The teaching of these two general science topics was very interesting and in all general aspects extremely successful. Everybody in the school system, from Dr. Forbes H. Norris, the superintendent, Miss Leonor Rich, the principal, the other classroom teachers in the building, the janitor, the parents of the pupils and most important of all, the pupils themselves, helped in making this unique undertaking a pleasant experience. The core of the units will remain as evolved in this thesis but a careful study of the acquired statistical data will encourage many minor detail changes. Foremost of the proposed plans are to lengthen the laboratory periods from thirty-minutes, five days weekly, to forty or forty-five minute periods, three days weekly.

More could be accomplished in this time schedule. Another must, will be to acquire from six to seven more of the basic reference books. The pupils read widely and got true research habits.

Conclusion.-- Because the work was individualized, the teacher had an opportunity to become far better acquainted with the pupils, and as a result could give them better guidance than in the traditional classroom procedure.

It was of particular interest to note that at the completion of the two units of study concerned in this thesis, a new topic of study was introduced and while this new topic had not proceeded along very far, twelve to fourteen pupils asked, "Aren't we going to be given study-and-activity-guide-sheets for this unit?" The entire group always felt that they knew just where they were and where they were headed for throughout the unit in this method.

The experience gained from the planning and teaching of these units gave sufficient assurance that, notwithstanding a few handicaps, unit organization is an excellent and practical method of teaching.

APPENDIXES

APPENDIX A

GROWTH IN SKILLS AND HABITS

Pupil's Name: _____

Skills and Habits to be Developed	Check Skill and Habit to be Developed	Period of Development	
		Anecdotal Account of Improvement	
		Unit on Air	Unit on Aviation
Using reference materials			
Organizing materials			
Showing neatness			
Showing accuracy			
Using tools of construction			
Following directions			
Reading effectively			
Reading for recreation			
Talking and writing effectively			

BEHAVIOR RECORD

Pupil's Name: _____

Personality Traits to be Developed	Check Trait to be Developed	Period of Development	
		Anecdotal Account of Improvement	
		Unit on Air	Unit on Aviation
Working with others			
Contributing to class-planning			
Showing initiative			
Using leisure time			
Accepting responsibility			
Respecting suggestions of others			
Showing effort			
Poise			
Leadership			
Dependability			
Courtesy			

A Trip to the Bedford Airport.

I. Planning the trip.

A. We stay together.

B. We keep our voices soft.

C. We do not touch the machinery.

D. We keep the same bus seats.

E. We ask the guide intelligent questions.

II. Taking the trip.

A. At the airport.

1. What were the airplanes doing;

a. on the field

b. in the air

2. What kinds of airplanes did you see.

3. Describe the airplanes you were allowed to see.

Look for:

a. size and shape of wings

b. type of fuselage, cabin, cockpit, etc.

c. landing gear

d. tail section

e. instrument panel, radio, etc.

f. size, type of propeller

4. Describe the hangars.

   a. what activities took place in the hangars.

5. Observe the size of the field.

   a. describe the runways - length, what they were made of.

6. What "lights" were there.

7. Was there a windsock or other wind direction indicator?

B. Where were the passengers and cargo travelling to or coming from?

APPENDIX B

STUDY AND ACTIVITY GUIDE BOOKLETS

Individual and small-group work.

A. Read this study and activity guide carefully. Check (✓) the items which interest you most. Can you think of any other really interesting things which might be done in connection with the unit? If so, be sure to let your teacher know. If at any later time you should think of any interesting activity not listed below, consult your teacher about the possibility of using it in this unit.

1. How deep is our ocean of air? Give the names of the different layers of air? (1:106-107) (2:199-200) (8:37) (9:5-8) 1/

2. What is the great heating force for the earth? Are all materials heated alike by this force? Why not? The teacher uses Figure 1 and the following questions for discussions: Why is the temperature at the surface of the soil greater than at three feet down? How do you explain the difference in temperature at the surface of soil and at the surface of the water? Why is the

1/ The numbers in each set of parentheses refer to a book and pages therein. The books are listed in the Pupil Reference List.

water three feet below the surface warmer than the soil three feet below the surface? Why is the water at the surface warmer than the water below? When does the sun give more heat at your home, at noon on June 21 or noon on December 21?

When does the earth get more heat from the sun, on June 21 or on December 21? Why? Why do you wear white clothes in the summer and dark clothes in the winter? What happens to the air as it cools? What results from the cooling and rising of air currents? (3:42-52) (1:44-53)

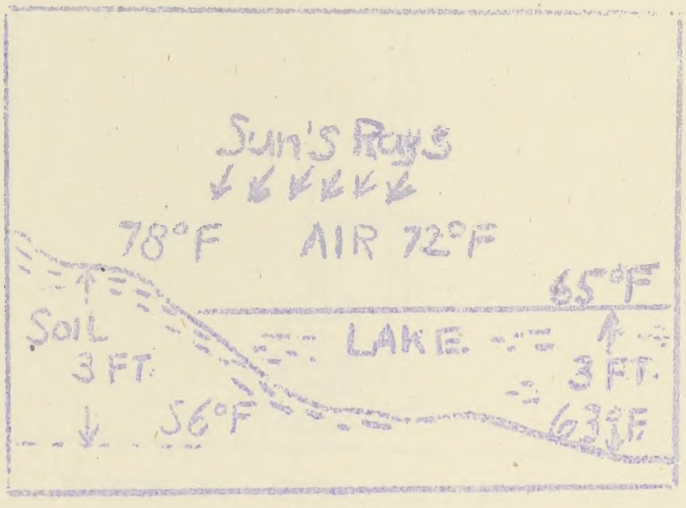

Figure 1. Does the sun heat different materials differently?

3. Demonstration: Galileo's thermometer (Figure 2). Teacher performs this experiment first. Get a glass beaker and fill two-thirds full of water colored red, place a quarter-inch glass tube twelve inches in length into the water. Draw a thermometer scale and place this in the background. Next heat the water in the beaker; then allow the water to cool. What happens to the column of water in the glass tube as the water in the beaker is heated? Why? What happens to the column of water in the glass tube as the water in the beaker is cooled? Why?

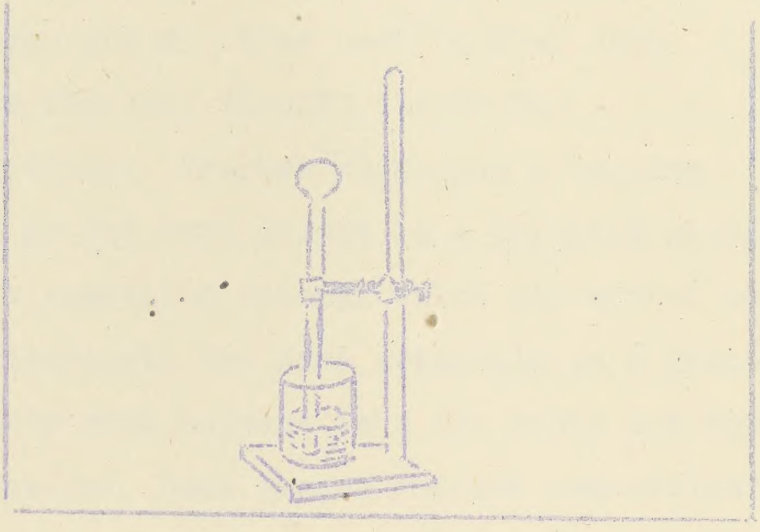

Figure 2. Principle of Galileo's Thermometer.

4. How many kinds of thermometer scales are commonly used? Which scale is the most commonly used? What is the boiling point of water on each scale? What is the freezing point of water on each scale? What does the word "thermometer" mean? What liquids are commonly used in thermometers? Why isn't air used in thermometers? (4:31) (5:4-20) (6:107-109) (20:14-15)

5. What is air made up of? What percent is there of each of the common gases in air? What gas do you inhale? What gas do you exhale? (1:118-119) (7:49-50) (2:173-177)

6. What common gas do fires need to keep them burning? (6:154-160) (1:118) (19:31-34)

7. Demonstrations: Teacher shows how a burning candle will go out when placed in a drinking glass covered with something through which air cannot pass readily. Illustrate the same principle in a kerosene lantern. Show what happens when air vents are employed.

8. Demonstration: Does oxygen support combustion? Teacher prepares and performs the following experiment. Heat in a test tube over a bunsen burner a spoonful of potassium chlorate which is mixed with manganese dioxide. Insert in the test tube a glowing splinter. What happens to the splinter? Insert a splinter which

has no glow. What happens? Why, What effect does oxygen have on burning? From this fact, what is one sure way to put out a fire?

9. What gas is deadly and often confused with carbon dioxide? What is the most dangerous thing a man can do while he has his automobile in the garage? Why? Why does carbon monoxide act so quickly in suffocating the victim? Where else is carbon monoxide found? (8:175-176) (19:37)

If you noticed a person who was being overcome with carbon monoxide gas what would you do? Is the oxygen tent or iron lung used in hospitals today of any help in this case?

10. What other gases besides carbon dioxide, oxygen and nitrogen are in the air? Which of these gases is commonly used for illuminated signs? What is helium used for? (1:119)

11. Make a circle graph five-inches in diameter and show the percentage of oxygen, nitrogen, carbon dioxide, and other gases.

12. Pupil demonstration: Drawing water into a glass from a saucer. A pupil appointed from each group prepares and performs the demonstration shown in Figure 3. Fold a two-inch square piece of newspaper three times. Now, bend the folded paper and float it

on the water in the saucer so that one end of the folded paper is out of the water and dry. Light the dry end of the folded paper. Immediately invert the empty water glass over the burning paper into the water which is in the saucer. Did the water rise in the glass? If so, why? Why did the fire go out?

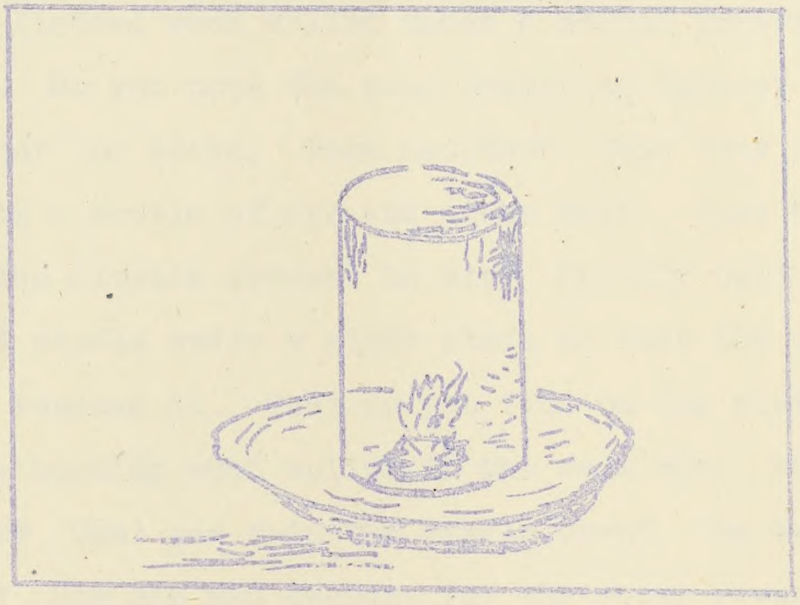

Figure 3. Drawing water into a glass from a saucer.

13. Demonstration to determine if presence of carbon dioxide is present in air? This demonstration is done by the teacher and later by a pupil. Hold the flame of a candle under the mouth of an inverted bottle for a few moments. Note carefully the inside surface of the bottle and observe the water there. Now pour some limewater into this bottle and shake it well. What happens? This is the test for carbon dioxide gas? Hold a lighted wood splint under a second inverted bottle. Do you note the same result as before? Pour limewater and shake. What happens? Then pour limewater in a bottle of air and shake well. What happens? Is carbon dioxide present in air? Finally hold the lighted candle under a glass plate so that the flame almost touches it. What do you find on the plate? Use the burning wood splint in the same way. What happens? What gas made the candle burn? The wood splint? How can you account for the water given off from the flames? The black substance on the plate is unburned carbon or soot. What are two products of the burning of wood or a candle?

14. If air is a substance does it have weight? How can it be proved that air does or does not have weight? (1:110-111) (10:16-17)

15. Experiment: Does air have weight? The teacher uses a football which is filled with air and weighs the football on a balance as in Figure 4.

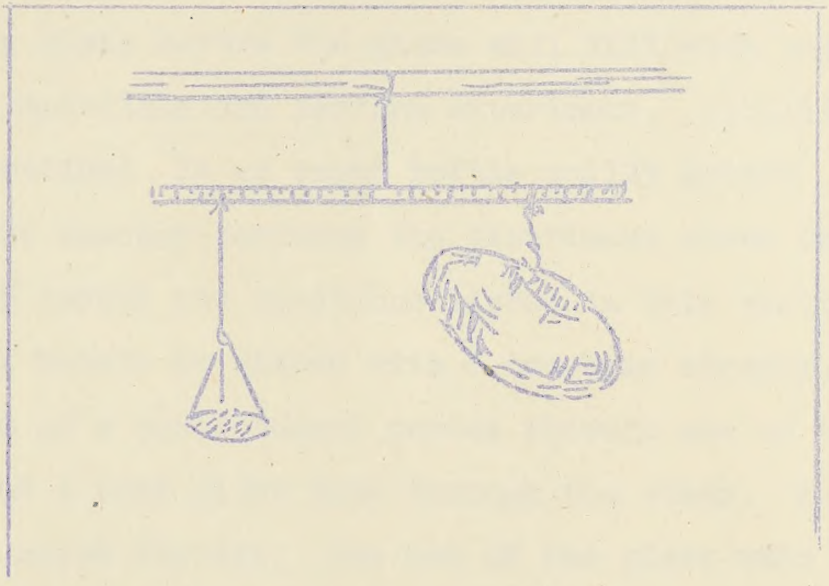

Figure 4. Does air have weight?

The football is then deflated and weighed again. Did the air in the football weigh anything?

16. Pupil demonstration: Weight of air. Cut out a square piece, one inch on a side, from a fairly thick board. Then weigh 15 pounds of books. Place your hand on the table, palm upward. Lay the square of wood on the palm of your hand and get a friend to pile the 15 pounds of books on the block of wood, holding the pile in place if necessary. The 15 pounds will feel quite heavy when they are resting on one square inch. Is this weight equal to the weight of all air above a square inch at sea-level?

17. Is an "empty" glass really empty? If not, why not? Why can't you fill a glass of water when you hold the mouth of the glass perpendicular to the surface of the water? The teacher demonstrates this to the class. What must be allowed to escape from the glass before the glass will fill with water? Prepare materials and perform experiment. (1:111)

Demonstration: Is an empty bottle really empty? After the teacher performs the experiment shown in Figure 5 answer the questions listed in this section. An empty bottle is fitted with a two-hole stopper. The stem of a small funnel passes through one of the holes and a bent glass tube through the other. Both fit the holes tightly. The end of the glass tube is closed by Holding a finger over it, and water is being poured into the funnel. (a) Does the water flow into the bottle? (b) What do you think is the reason for the action of the water? The following questions are to be answered after the finger has been removed from the end of the glass tube. (c) What happens to the water when the finger is removed? (d) What reason can you give for the action of the water in this case? A lighted candle is placed near the open end of the delivery tube while water is

poured into the funnel. (e) What happens to the candle flame? (f) Where does the air come from?

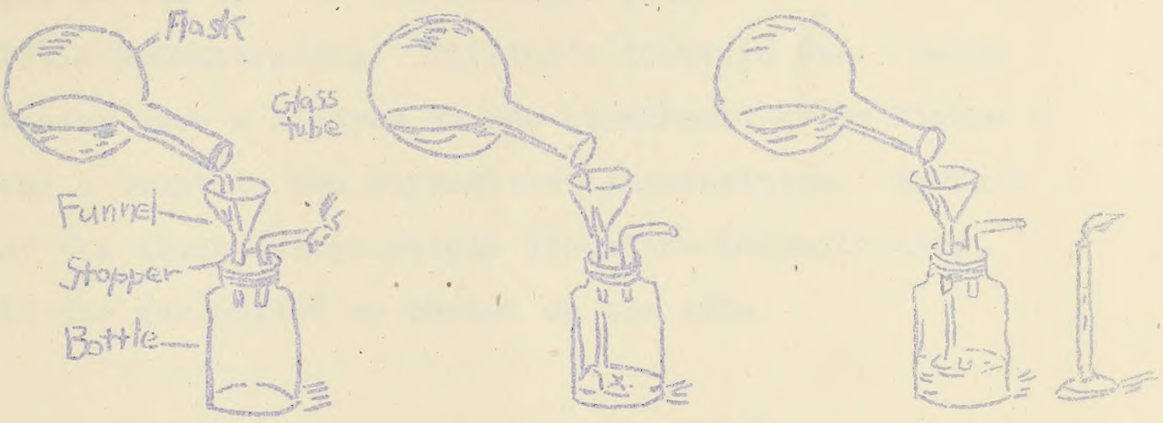

Figure 3. Is an empty bottle really empty?

18. Does air exert or make a pressure? Can you prove this? How? Is air compressible? If so, How? What previous experiment proved that air is compressible? (4:37-38) (11:26-29)

Demonstration: Air makes a pressure and is compressible. The teacher blows up a balloon. Questions directed to the pupils. Is air being compressed? Why do the sides of the balloon stay out? Does air exert pressure?

19. What are some common uses of compressed air? List them on paper. (1:112) (10:18) (11:29-35)

20. Demonstration: Operation of the soda straw. Why does the soda come up the straw? Is soda pulled up the straw, or forced up?

21. How many own a fountain pen? How does the ink get in the tube of the fountain pen?

Pupil demonstration: Filling a fountain pen. Group leader uses a diagram on the blackboard as in Figure 6 and a fountain pen during the demonstration. Members of the class ask questions about the demonstration. Is the ink pulled or pushed up the tube.

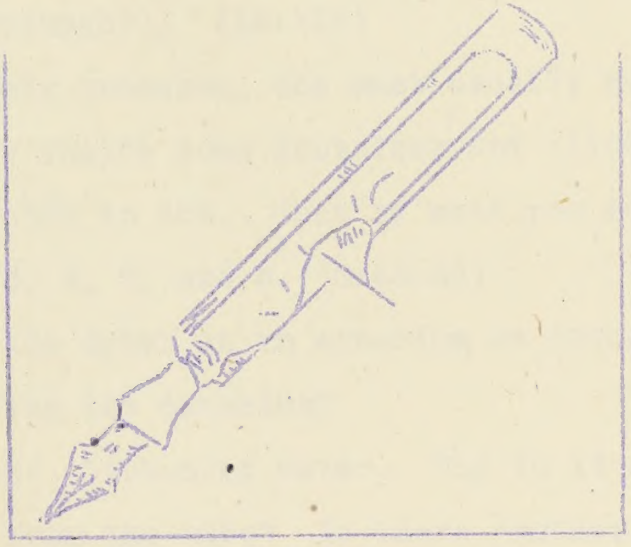

Figure 6. Operation of a fountain pen.

22. Demonstration: Uses of the soda straw. Place a soda straw vertically into a glass full of colored water. Cover the top opening of the straw with a

finger and draw up the straw. Does the water stay in the straw? Why? Remove the finger from the top opening of the straw. What happens? Why?

23. Demonstration. The eyedropper. Operate the eyedropper by using colored water in a glass. What is the principle of the eyedropper? (13:32)

24. Demonstration: The operation of a bicycle pump. Take the pump apart and explain the use of the important parts to the class. Use blackboard diagrams. (12:120) (13:28)

25. Demonstration: Demonstrate the principle of the force cups (plunger). (12:114)

26. To show air pressure, one must usually make the pressure less inside some container and allow the air pressure outside to act. That is what you must do in experiments 5, 6, 7, and 8. (8:45-46)

27. How may the water in an aquarium be changed without tilting the aquarium?

Demonstration: Siphoning water. Why is it necessary to take air from the tube? Is there another method of starting the siphon besides drawing the air out of the tube? How? Will a siphon operate if both containers are at the same level? Why? (10:13-15) (1:113-114) (13:33-34)

28. How much does the air in this classroom weigh? Estimate the weight then compute the answer on the basis that one cubic foot of air weighs about one and one-quarter ounces.

29. Differences in air pressure at different heights. The teacher demonstrates air pressure with a pile of six books to represent the air column. The bottom book represents sea level. Using the books as the column of air, the teacher asks, Where is the air pressure the greatest? Least? Half? What instrument is used to measure air pressure? What are the uses of this instrument? (3:203-204) (12:106-107) (4:39-40) (14:46-47)

30. Demonstration: Air pressure holds water in an inverted glass with the aid of a cardboard cover. Fill a glass two-thirds full of water. Place a piece of cardboard over the top and hold the cardboard while you invert the glass. See Figure 7. Remove your hand carefully. Why doesn't the water flow out?

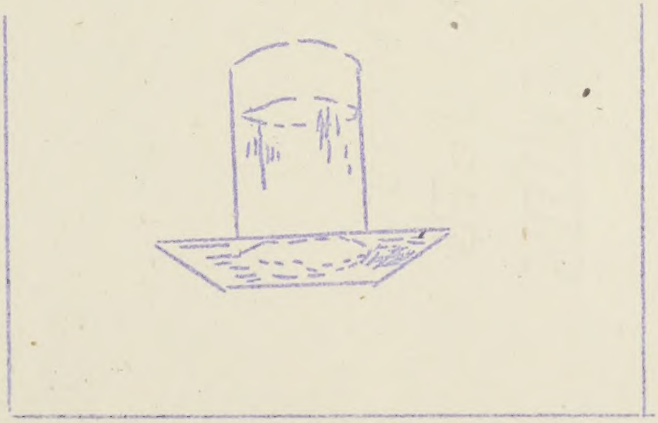

Figure 7. Air pressure with aid of cardboard holds water in an inverted glass.

31. Demonstration: Air pressure forces a hard boiled egg in and out of a milk bottle. Prepare the materials as follows: Boil an egg for ten minutes. Place it in cold water for ten seconds. Shell the egg. Fold a square piece of toilet tissue four times. Light the tissue paper and throw it into a quart milk bottle. Immediately place the egg on the opening of the bottle. The problem is to see if the egg will go into the milk bottle. What forced the egg in the bottle? How did the lighted paper weaken the air pressure inside the bottle? How can we take the egg out of the bottle by the use of air? (10:19-20) (15:373)

32. The caisson. What is a caisson? How does the caisson work? Perform experiment and describe principles to class. (1:116-117) (10:8-9)

33. Oxygen required in our body. What is the function of oxygen in our body? Why do we sometimes need to have an oxygen tent in a hospital? What is an iron lung? (16:162-165) (13:54) (7:52-53) (12:165) (2:216,221)

34. Demonstration: The operation of an iron lung. Pupil leader prepares and performs the demonstration shown in Figure 8. Place a two-hole stopper in the opening of a pint size bottle. Insert a straight glass tube in one of the holes of the stoppers. Fasten a balloon on the end of the glass tube which is in the bottle. The balloon represents a lung. Insert a right

angle glass tube two inches into the other hole of the stopper. This second tube represents the bellows which draws the air out of the chamber. In operating the device the pupil draws the air out of the right angle tube. This causes air to rush in the straight tube which, in turn, inflates the balloon. When the pupil takes his mouth off the glass tube, the lung, represented by the balloon, becomes deflated. The series of inflation and deflation of the balloon represents the breathing of a person lying inside an iron lung.

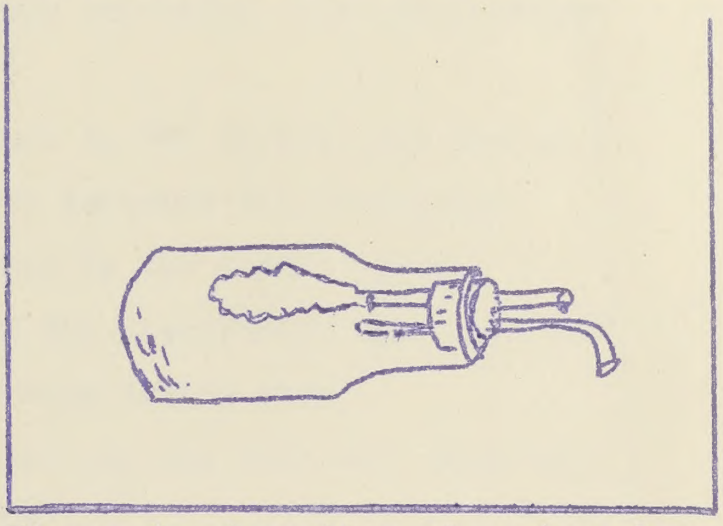

Figure 8. Operation of an iron lung.

35. A trip to the hospital to see the operation of the oxygen tent and the iron-lung. Read the following questions. You are expected to know the answers by the end of the trip.

A Trip to the Hospital

Iron-lung:

1. What is the size of the air chamber?
2. How is the breathing regulated?
3. Why is the collar which is placed on the occupant made of rubber.
4. Has the occupant of the iron-lung freedom of body and heat? What activities can he perform?
5. What is the purpose and use of the iron-lung?
6. Who invented the iron-lung?
7. What is the cost? Upkeep?
8. If the electricity were shut off would the person inside die?
9. What are the four most important parts?

Oxygen tent:

10. Describe the oxygen tent.
11. What is it made of?
12. How does it work?
13. When is it used?

36. There is always some water vapor in the air. What happens if the air is cooled? If the air is warmed? How are clouds formed? Why do people call a cloud "dark"? What happens when there is more water vapor in the air than it can hold? (17:3-5) (8:41-42;149-154) (13:102)

37. Tell what "cirrus" clouds look like? How high are they in the sky? What kind of weather do they indicate? (4:43-44) (17:11) (12:563) (14:53-55) (19:69-70)

38. Tell what "cumulus" clouds look like? What nickname is given them? What kind of ewather do they indicate? (4:44) (17:5;11) (19:69-70) (14:54) (12:563)

39. Tell what "stratus" clouds look like? What kind of weather can you predict from them? (4:45) (17:10-11) (12:563) (14:53-54) (19:69-70)

40. Tell what "nimbus" clouds lokk like? What do they indicate? (12:563) (14:53-55) (19:69-70)

41. How do the great winds of the earth circulate? How is it that the air keeps moving and causing winds? Is the air warm at the equator? What happens to this air? In which direction does the cold air from the North Pole go? What happens when warm air and cold air meed? What causes "warm fronts"? "Cold fronts"? (8:154-165) (4:51-54) (13:110) (10:23-24) (20:22-25)

42. How is the speed of the wind measured? What is the instrument called? How can you tell the wind's direction around your neighborhood? (14:48) (12:550) (20:22-25)

43. Name the machines which use air? How does each machine use air?

List additional findings of your research here:

Vocabulary

gas
compressed
barometer
thermometer
siphon
Torricelli
Galileo
atmosphere
drafts
neon
carbon dioxide
combustion
cirrus
cumulus
nimbus
stratus
front
caisson
anemometer
vapor
nitrogen
carbon monoxide
stratosphere
condensation
currents
cylinder
inflate
exert
device
velocity
pneumatic
mercury
troposphere
oxygen

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UNIT - "MEN FLY"
The Airplane Now and In The Future

Study and Activity Guide

Read this study and activity guide carefully. Check (✓) the items which interest you most. Can you think of any other really interesting things which might be done in connection with the unit? If so be sure to let your teacher know. If at any time later you should think of any interesting activity, not listed below consult your teacher about the possibility of using it in this unit. You are to keep a notebook for this unit.

1. How long ago did man think of flying and what made him want to fly? There were many trial flights and inventions in the field of flying before the airplane became too important. Can you imagine how the first man that attempted to fly did it? Did he get his idea from a bird, a flying leaf, a kite, or just where did he get it? Who were Daedalus and Icarus? (5:11-14; 27-29) (3:19) (15:439)

2. What was Leonardo da Vinci's contribution to flying? Where did he get his ideas of flight? Tell the story of his toy helicopter. (26:31) (4:63) (5:50-52)

3. How did seeds give man ideas about flying? What part of the seed acts as a parachute? Name the words that go to make up "parachute". (5:37-42)

4. What race of people invented the kite? What are kites used for? Tell why a person holding a kite runs behind for a short distance and throws the kite into the air. What kinds of kites are there? Why do kites fly? (5:43-46) (3:24-26) (8:130-131) (1:53-55)

5. The first man who went into the air used a balloon. Why do balloons rise? Why is a balloon in the air like a piece of wood in water? Explain reasons why a balloon will rise? What gases are commonly used in balloons? (1:58-72) (5:47) (26:31)

6. Describe the experiments of the Montgolfier brothers. Tell when and where these experiments were made? What was their balloon filled with? Who were the first passengers? How long did the first balloon trip last? Describe other early balloon flights. (10:129-130) (5:48-49) (1:59-61) (15:442-443) (27:5-9) (26:23-25) (8:135-139) (4:63-68) (3:26-29)

7. What are the uses of the balloon and dirigible? (1:61-72) (3:29-30)

8. Demonstration: Some things float; others sink. Pupil leader prepare materials and show that some float and others sink. Get an aquarium or tank and fill it with water. Try floating the following solid materials; a wood cork, an empty stoppered bottle, stones, a sponge, etc. What do you notice about the objects that feel light for their size? What happens to the heavier objects? Will iron objects float? Try floating an empty tin can in the tank. Does it float? Take the same metal can and smash it flat, although its weight has not been changed, its volume or size has. Does it sink when flattened out? If we increase the weight of an object and not alter the volume or size will it float? Take a floating tin can and put sand or water into it, thus increasing the weight. What happens to the weighed can?

9. Demonstration: A floating object pushes aside its own weight of water. Pupil leader prepares materials and performs the demonstration. Get a spill can and a sensitive scale. First weigh very carefully a clean dry water tumbler. Fill the spill can very carefully until water starts to run out the spout. (see figure 8) Let the water stop running. Carefully weigh a block of wood of a size which will fit in the spill can. Place the weighed tumbler under the spout of the can to catch any water which may run out. Gently lower the weighed block into the can of water until it is floating freely, meanwhile catching all the water which is forced out the spout. Allow the water to stop flowing, and then weigh the tumbler with the water it contains. Subtract the original weight of the tumbler to get the weight of the water which was forced out of the can. Is the weight of the water about equal to the weight of the wooden block? What does this tell us about floating objects? Why does the wood block rise again if it is pushed under the water? Do balloons push aside more

9. Demonstration: (continued)
than their own weight of air? Does this tend to make balloons rise until the weight of air pushed aside equals the weight of the balloon?

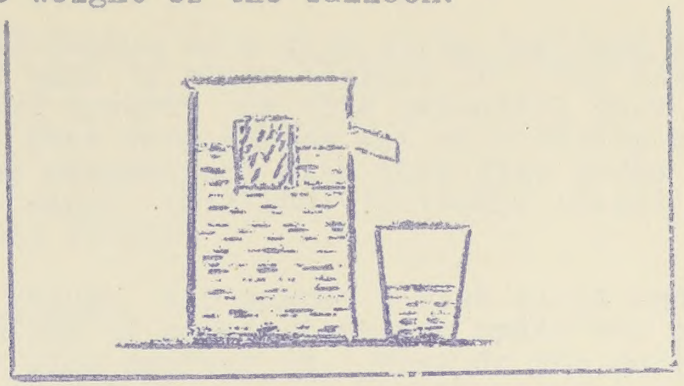

Figure 8. Measuring the water displaced by a block of wood.

10. Demonstration: Pupil leader perform the following experiment. Partly inflate a small balloon and try to push it under water. Use an aquarium two-thirds full of water and a toy balloon for the experiment. What principle previously shown does this experiment show us?

11. Demonstration: Air expands when it is heated. Pupil leader prepares materials and performs the following experiment. Fit a small rubber balloon over the mouth of a Pyrex nursing bottle. Heat the bottle with a flame (use alcohol burner). What happens to the balloon as the air in the bottle becomes heated? What does this show us about air when it is heated?

12. Is heated air pushed up by cooler air?
Demonstration: Pupil leader prepares materials and performs following experiment. Suspend a yardstick from a string tied around its middle. From each end of the yardstick suspend, mouth down, a paper grocery sack of about five pounds capacity. Get the two sacks to balance each other exactly by sliding the strings which hold them along the yardstick. Be sure the room is free from drafts which would disturb the balance. (see figure9) When the sacks are balanced, hold a lighted candle under one to heat the air in it. What happens to the heated sack? What does this show about heated air?

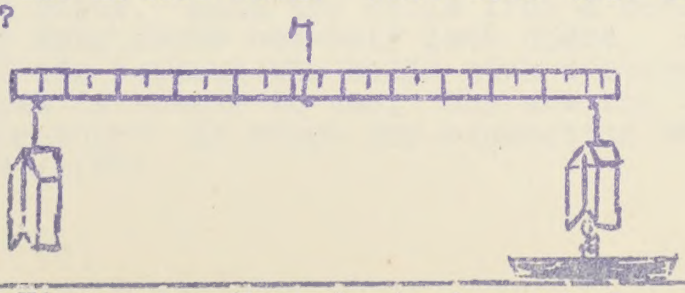

Figure 9. Heated air is pushed up by cooler air.

13. Why are balloons and dirigibles called "lighter-than-air"? (3:39) (5:47) (8:134) (27:3) (1:58) (7:274-279)

14. What will happen to a flat plate inclined forward at an angle if wind is blown against it? Why does the flat plate move upward? Is this principle used in kite-flying? What four forces act on a flying kite? Is there any resemblance with this flat plate and an airplane wing? (3:41;25) (1:79-80) (5:45) (28:12-13) (11:23-30) (20:10)

15. Demonstration: Air pushes a flat plate upward. Hold a flat piece of paper slantwise under the palm of the hand and blow against it. What do you notice about the paper as lonh as your breath continues to strike it? What happens when you stop blowing against the paper? Hold the paper in a similar position and run with it. Does this have the same effect as blowing on it?

16. How can the path of air currents blowing against a flat plate be improved? What are "eddies"? What effect do "eddies" have on the flat plate? (3:41) (26:19)

17. Describe the early experiments that led to successful flying of the following aviation pioneers: (4:72-85) (1:75) (15:444-449) (5:55-66) (8:131) (22:85)
    a. John J. Montgomery
    b. Otto Lilienthal
    c. Octave Chanute
    d. Wright Brothers
    e. Samuel P. Langley
    f. Sir Hiram Maxim

18. What makes a wing lift? What is the shape of most airplane wings? Explain reason for having the front edge of a wing thick and the rear edge thin. Is this a "streamline"? What is meant by drag? What causes a "vacuum" above the wing? (1:76-81) (8:132-133) (3:42-44) (28:15-17) (15:449) (4:87-88) (5:67-71) (16:37-42)

19. Experiments to show why a wing lifts: a. Get two ping-pong balls. Fasten a string about eight inches long to each of them, using a little glue or a piece of gummed paper. Hang the balls from a pencil, so that they hang about one-half inch apart. Blow a stream of air between the balls with a straw. A large straw is better to use. Why are the balls pulled together? Is there any connection with air pressure? (1:82)

19. Experiments (continued)
b. Hang two teaspoons back to back and a little way apart. You will probably need to use an arrangement of two pencils and two strings to hold each spoon steady. Blow air between the spoons with a straw. Do the spoons come together? Was the air pressure between the spoons lessened by blowing between them? (1:83)
c. But two squares of typewriter paper about six inches on a side. Glue or paste opposite edges of each square together. You now have two light paper tubes. Lay two long pencils side by side on the table so as to form a pair of rails on which the paper tubes can roll. Lay the tubes on the pencils, side by side and about an inch apart. Blow between them. Are the tubes blown together or are they blown apart? (1:84-85)

20. What is meant by "stalling a plane"? Is it the same as stalling an automobile? What is the result if a pilot "stalls" one wing while the other wing is still "lifting"? How far can an airplane glide if it is one mile high? (1:87-88) (4:89-91)

21. We have discovered that an airplane's wing must be in motion in order to stay aloft, therefore we must have an "engine". What are the main parts of a gasoline engine? What does each part look like? How is each part related to the other? (1:91-97) (3:66-70) (7:421) (16:310-315) (28:164-189) (4:177-191) (15:449)

22. How is an airplane propeller different from a windmill? Is there any resemblance in a propeller and a wing? Where is the low pressure found when a propeller is in motion? Where is the high pressure found when a propeller is in motion? What is meant by "feathering" a propeller? Why is this done? Give a reason why propellers are usually made of about two or three blades? (1:98:100) (29:375) (31:219-233)

23. Demonstration: Compare a home-made pin-wheel type propeller (1:101) with a rubber-ban-powered propeller on a model airplane.

24. Of what use is the fuselage? What names are given to the section where the pilot, passengers sit? What is the shape of most fuselages? Is there another purpose for the fuselage? (10:133) (30) (15:450)

25. Is an airplane steered in the same way as an automobile? Is the airplane steered in a similar way as a boat? In how many different ways is an airplane steered? What is the turning motion to the left or right called? What is the tilting to left or right called? What is the movement of the nose up or down called? (1:106-110) (7:393-396) (28:19-21) (4:92-94) (12:319)

26. Where are the stabilizers located on an airplane? What is there purpose? Do they help the plane to fly level? (1:111) (7:396-397)

27. What is the purpose of the airplane's fin? Where is it located? (1:112) (26:168) (7:396-397)

28. What parts of the airplane help the pilot "dive" or "climb"? (1:113-114) (7:396-397)

29. What part of the airplane helps the pilot to turn to the right or left? How can you tell this section from the fin? (1:114) (7:396-397)

30. What are the ailerons? Where are they located? When one aileron goes up the other goes down, can you tell the reason for this? (1:114-115) (26:147-157)

31. Demonstration: With the use of a model airplane having moveable parts explain how each part affects flight. Make a diagram on large oak tagboard or on the blackboard showing how each part is connected and how the pilot controls the plane. Make sure to demonstrate the use of the "stick" and the "pedals". (31:24)

32. Why does an airplane need many more instruments for its operation than the automobile does? Describe what each of the following instruments is used for: (4:193-206)

    a. tachometer (1:134-136) (28:100)
    b. altimeter (1:136-138)
    c. compass (1:138-140) (21:211-224) (33:81-87)
    d. turn-and-bank indicator (1:140-141) (28:145)
    e. oil pressure gauge (1:132)
    f. oil temperature gauge (1:132-134) (28:100)
    g. fuel gauge (28:100)

33. Demonstration: The gyroscope -- a part of many airplane instruments. Procure a toy gyroscope and perform the experiments shown in reference (3:74)

34. Why is weather one of the most important things to a pilot? When we speak of "what weather is" are we speaking of the condition of the atmosphere? How many kinds of atmospheric conditions make up weather? (1:144-147) (32:99) (21:184-196)

35. Write a short paragraph, for your notebook, explaining each of the following kinds of atmospheric conditions: (1:147-154) (21:187-196) (9:54-56)
    a. temperature
    b. atmospheric pressure
    c. humidity
    d. wind
    e. sunshine
    f. clouds
    g. rain, snow, hail, or sleet

36. Explain why it is necessary for aviators to know what the weather will be? What are some of the weather signs? What is the work of the Weather Bureau? (35:101-121) (21:198-206) (9:43-53; 56-72) (1:160) (36:49-78)

37. What are some of the weather superstitions? (9:58-59)

38. What do the terms "ceiling" and "visibility" mean in aviation language? Is the word "CAVU" a good report for a pilot to hear? (1:144)

39. Name some of the ways a pilot can judge the speed of the wind? Use the Beaufort table (21:206). This list is to be kept in your notebook.

40. Study the weather map carefully (21:200). How can you tell from this map that Minneapolis will probably have cooler, clear weather in a day or two? Bring to school a weather map from your daily newspaperand predict the weather for the next few days. (32:101-109) (16:109-114)

41. What is navigation? Who does the navigating in most planes? What type of planes employ a person whose main duty is "navigating?" What are the advantages of having a full time navigator in an airplane? (1:171) (3:116)

42. What is the simplest form of navigation? Name the aids used in this form of navigation? What are the advantages and disadvantages in the "piloting" type of navigation? (1:172-173)

43. Give reasons why "dead reckoning" is the most useful of all methods of navigation? Why must the wind be taken into account in dead reckoning? What instrument is necessary in dead reckoning? What is meant by variation of the compass? 1:173-180) (18:139-154) (29:300-307) (12:278-287) (33:85-88)

44. What is meant by "flying on the beam"? Explain how radio is an aid to navigation. What is the greatest advantage of radio navigation? What ground instruments are necessary for radio navigation? (1:185-197) (4:291-303) (28:220-232) (36:172-198)

45. What is radar doing for the aviator? Write to a commercial airline company asking for the use they are making of radar.

46. Demonstration: How the airplane's loop aerial functions. With the aid of a portable radio perform the following demonstration. Turn on the radio, tune in a station, and lower the volume control until the station comes in very softly. Pick up the set and turn it slowly around. You will probably find two places where it comes in quite loud. This happens because most portable radios have loop aerials. Repeat the experiment several times, using different broadcasting stations. Where is the loop found on airplanes? In which two ways may the loop be used? Is the loop a direction finder? (1:192-195)

47. Why is celestial navigation the most accurate for long flights? How can pilots tell their position by the "stars"? Explain how the "sextant" is used. How are maps used in this type of navigation? (1:180-182) (37:217-218;320;323-354) (18:113-122) (6:5-26)

48. How do we locate places on the earth? Explain on a globe meridian lines -- longitude and latitude. How has the airplane created a new world of geography? (1:199-202) (2:1-6) (5:75-82)

49. Men in aviation need a knowledge of the following maps, write a descriptive paragraph about each type for your notebook:

    a. cylinder maps (1:203-205) (2:12-15)
    b. Mercator map (1:205-207)
    c. Lambert's map (1:207-209)
    d. Polar projection maps (1:209-211) (2:41-44)

50. What is the easiest way to find the shortest route between any two places on a globe such as the earth? What is a great-circle? Are parallels great-circles?

51. Demonstration: The importance of great-circle routes. On the school globe stretch strings from the place where you live to a number of important cities, such as Moscow, London, Berlin, Tokyo, Paris, Lisbon, New York, and Liverpool. Notice the routes taken by the strings. Notice also that, since many of the world's important cities are in the northern hemisphere, many of the strings pass over Alaska, the Arctic Ocean, or Greenland.

Look at the Mercator map and the polar map on pages 206-210 of reference 1. Look at the lines drawn between Tokyo and the Panama Canal, between New York and Moscow, and between New York and Rio de Janeiro on the Mercator map. Those look like the shortest distances to those cities. What places would a plane pass over if it flew the routes marked on a Mercator map?

Now look at the lines drawn between these same places on the polar map. Are you surprised to see that a plane taking the shortest distance from Japan to the Panama Canal would fly over Alaska, Denver, and the Gulf of Mexico? The lines drawn are not quite straight, because they show the great-circle routes between the cities which have been mentioned. Compare these shortest-distance routes with the routes on the Mercator map. Over what places would a plane fly on the shortest route between any of the pairs of cities mentioned?

Suppose you were the person in charge of one of the great airlines. Your airliners would be carrying people and goods between all the chief cities of the world. Which kind of map would you use to plan the routes for your airliners?

52. Aviation is now a vital link in the transportation system of the world. How has the airplane made all the world "neighbors"? What are the advantages of air-travel? (38)

53. Field trip. Teacher conducts class to the Bedford, Mass. airport. The pupils will better enjoy the trip if they become acquainted with the following: (5:91-95) (7:381-404) (1:3-28)

a. flight planning
b. runways - landing rules - tower
c. hangars - plane maintenance.
d. lights - beacons
e. passengers and cargo

54. Men who fly need to be healthy. Why does high altitude affect breathing? What is the pressure of air at sea-level? What happens to the air as one goes up into the higher regions of the atmosphere? What happens to the body when one suffers from lack of oxygen? What is "anoxia"? What visible signs tell us when a pilot has anoxia? How can anoxia be prevented? (28:167-171) (8:140-141) (36:319-320)

55. The temperature of the air becomes cooler as one goes high into the air -- until the stratosphere is reached. What kind of clothing does the pilot need? (32:527-531) (35:77-80) (16:388-391)

56. What are some of the common ailments that confront the pilots? How does the novice flyer feel when the air is rough? What causes black-out? How may black-out be prevented? (Encyclopedia)

57. Why does the aviator need perfect eyesight? What are some of the eye defects that would keep a person out of flying? (36:321-326)

58. What are sense organ aids in the orientation of a pilot? How does hearing aid the pilot?

59. How have women helped the aviation progress? Make a list of famous women flyers and give their achievements. (4:222-238)

60. What is the future of aviation? What opportunities are there for the future young flyers of America? (4:239-272;315-327) (36:200-242) (15:454-456) (29:377) (5:133-135) (3:95-100)

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APPENDIX C

EVALUATIVE ACTIVITIES

Questionaire for "Air and You"

Section I--True-False Items

Directions for true-false items: Read each statement carefully. If you believe the statement to be true, pencil a circle around the "T". If you believe the statement to be false, pencil a circle around the "F".

T F 1. Air is all about us.

T F 2. We could live without air.

T F 3. Air is visible.

T F 4. Streamlined objects are made so that they can move through the air easily.

T F 5. We can feel air if it is moving.

T F 6. If we should go up in a balloon 15 miles above the surface of the earth, there would still be air around us.

T F 7. We must have air in order to live.

T F 8. Birds, dogs, and trees do not need air.

T F 9. Air presses up and down and sideways.

T F 10. A volume of warm air is heavier than the same volume of cold air.

Section II--Completion Items

Directions for completion items: Complete the following statements correctly by filling in each blank with one word from the list of words below.

expand	gases
thermometer	invisible
motion	air
contract	dust
fish	clouds
compound	water

1. Air takes up space even though it is _____.
2. Wind is air in _____.
3. Air is made up of several _____.
4. We use _____ to find out how hot or cold anything is.
5. Almost all materials _____ when heated and _____ when cooled.
6. There is always some water vapor in the _____.
7. _____ come to the top of the water for air.
8. _____ are made up of drops of water or crystals of ice.
9. Particles of _____ are found in the air.
10. When water vapor is cooled, it may change to drops of _____.

Name:_____ Date:_____

Air and You Quiz
Mid-Unit

Part I: True-False: Draw a circle around the "T" if the statement is true. Draw a circle around the "F" if the statement is false

1. T F Air pressure at sea-level is 15 pounds per square inch.

2. T F The stratosphere is the layer of air nearest the earth.

3. T F The sun is the great heating force of the earth.

4. T F There are two kinds of thermometer scales in use one is the Fahrenheit scale and the other is the Centigrade scale.

5. T F On the Centigrade scale the freezing point of water is 30 degrees F and 100 degrees F is the boiling point for water.

6. T F The air we breathe has about 76 percent nitrogen, 20 percent oxygen, and 4 percent mixed gases.

7. T F A glowing splint placed into a test tube with heated potassium chlorate and manganese dioxide will burst into flame.

8. T F Carbon dioxide, the gas that comes from the engine of an automobile, is a deadly gas.

9. T F Carbon monoxide is an invisible, tasteless gas and very poisonous.

10. T F Soot made by a flame is unburned carbon.

11. T F There is no water vapor in the air.

12. T F In the football bladder experiment we proved that air has weight.

13. T F In the soda-straw demonstration we proved that the air forced up the liquid.

14. T F Neon gas is used in balloons and dirigibles.

15. T F Limewater is used in the test for carbon dioxide.

16. T F Helium is used in signs on many of our stores and movie theaters.

17. T F In testing for carbon dioxide the limewater will turn milky in color if there is carbon dioxide.

18. T F The higher a person goes up in the sky the more oxygen he finds.

19. T F The atmosphere extends over 200 feet up into the sky.

20. T T There is more air pressure at sea-level than at 30,000 feet altitude.

(turn your paper over until it is collected)

Pupil's Name:_____ Date:_____

Mastery Test on Unit "Air And You"

I. Making the statements correct: Directions. From the list at the bottom of the page choose a word that will make each of the following sentences correct. Write the number of the correct word on the line at the right.

Air can be weighed on a (1) with the aid of a football. 1_____

When air is heated it (2). 2_____

Man inhales (3) and exhales (4). 3_____ 4_____

The air pressure is about (5) pounds per square inch at sea level. 5_____

The principle of the medicine dropper, lift-pump, and siphon, is to (6) the air pressure in the tube, causing the (7) air pressure to (8) the water up into the tube. 6_____ 7_____ 8_____

As you go up into the earth's atmosphere the air pressure (9). 9_____

In the lift pump and the bicycle pump (10) are used to control the air. 10_____

1. oxygen
2. fifteen
3. decreases
4. carbon monoxide
5. force
6. scale
7. lessen
8. valves
9. carbon dioxide
10. expands
11. outside
12. Galileo
13. thirty

II. True-False: Directions. Read the following statements carefully, if you believe the statement to be true underline the letter "T". If you believe the statement to be false, underline the letter "F".

1. T F Wind has force, and people have learned to put the wind to work.

2. T F Air presses on things on the surface of the earth with great force.

3. T F There are five common thermometer scales in America.

4. T F Oxygen, nitrogen, and carbon dioxide are three of the gases in the air.

5. T F Cold air is lighter than warm air.

6. T F Water warms up quicker than air.

7. T F Fires need oxygen to keep them burning.

8. T F Carbon monoxide is a very dangerous gas.

9. T F Neon gas which is found in small amounts in air is used for dirigibles.

10. T F Soot is unburned carbon.

11. T F The pressure of air at sea level is fifty pounds per square inch.

12. T F When we inflate our bicycle tires we prove that air is compressible.

13. T F The caisson is an instrument used to measure air pressure.

14. T F When we use a soda straw in drinking the liquid is forced up into the straw and not pulled up.

15. T F We may change the water in an aquarium by using a barometer.

16. T F A siphon is a device used to change water from a higher level to a lower level.

17. T F There is no difference in air pressure at different heights.

18. T F It is possible to force a hard boiled egg into a milk bottle with the aid of air pressure.

19. T F An iron lung is used to replace an injured lung.

20. T F Cumulus clouds are big fluffy clouds.

III. Matching: Directions. Place in the blank at the left the number of the item which it identifies.

_____ centigrade	1. Made the first thermometer.
_____ cirrus	2. An instrument to measure air pressure.
_____ stratus	3. Clouds high above ground that look like curls or mares' tails.
_____ anemometer	4. Thermometer scale with freezing point of water marked at zero degrees.
_____ cumulus	5. Clouds that are in layers.
_____ Fahrenheit	6. An instrument to measure the speed of the wind.
_____ nimbus	7. Large fluffy clouds.
_____ barometer	8. Thermometer scale with boiling point of water marked at 212 degrees.
_____ weather vane	9. Shapeless clouds from which rain falls.
_____ Galileo	10. An instrument to measure water vapor.
	11. A wind direction indicator.
	12. Measuring compressed air.

IV. Directions: Read carefully each numbered sentence below. Then read the statements under A, B, C. Make an (X) to the left of the letter of the statement which best agrees with the sentence.

1. The region along which a mass of warm air and cold air meet is called a front.

__A__ As a result of this the lighter warm air is always pushed upward above the heavier cold air.

__B__ The lighter warm air is never pushed upward above the heavier cold air.

__C__ The heavier cold air is always pushed upward above the lighter warm air.

2. When air is heated, it expands and gets lighter.

__A__ The air will then settle to the ground.

__B__ The air will cause an explosion.

__C__ The heavier cold air around the heated air pushes the lighter warm air upward.

3. The speed, or velocity, of the wind depends;

__A__ upon the direction it comes from.

__B__ upon the difference in the pressure.

__C__ upon the weather.

4. By removing the air from a gallon tin can,

__A__ the sides of the can will break outward.

__B__ the sides will crush inward.

__C__ the sides will remain the same.

5. In the siphon experiment we proved that

__A__ the air pressure pushes water from the vessel upward into the bent tube.

__B__ the water was drawn downwards because of the air pressure on the lower vessel.

__C__ the water could not be transferred from one vessel to another through a bent tube.

6. Air is a mixture made up of about,

__A__ 78 percent oxygen, 20 percent nitrogen, and 1 percent neon.

__B__ 50 percent oxygen and 50 percent carbon dioxide.

__C__ 21 percent oxygen, 78 percent nitrogen, and 1 percent of other gases.

7. Materials will burn as long as,

__A__ oxygen is supplied and the material lasts.

__B__ carbon dioxide is supplied and the material lasts.

__C__ nitrogen is supplied and the material lasts.

8. The boiling point of water at sea level on the Fahrenheit thermometer is,

__A__ 100 degrees Fahrenheit.

__B__ 212 degrees Fahrenheit.

__C__ 32 degrees Fahrenheit.

9. Air exerts pressure on objects

__A__ because of its gases.

__B__ because of its depth.

__C__ Because of its weight and motion of the molecules due to heat.

10. Compressed air is used in all of the following devices,

__A__ tires, doorchecks, pneumatic hammers, and caissons.

__B__ pneumatic hammers, doorchecks, and vacuum cleaners.

__C__ vacuum bottles, tires, air-brakes, and dirigibles.

Name: _____ Date: _____

Progress Test-"Men Fly" (History-buoyancy)

True-False: Make a circle around the "T" if statement is true and do the same around the "F" if statement is false.

T F 1. Daedalus and Icarus were two legendary people.

T F 2. Man's first flight was done with a glider.

T F 3. Kites usually have a tail to make them fly better.

T F 4. A balloon in the air is like a piece of wood in the water.

T F. 5. Balloons are called "heavier-than-air" crafts.

T F 6. Dirigible means to steer.

T F 7. An object is ~~Xmxy~~ buoyant if it floats in the air or in the water.

T F 8. Pigs, chickens, were the first airplane passengers.

T F. 9. Man has only recently thought of flying.

T F 10. The Montgolfier brothers designed the first glider.

Fill in the blanks to complete the statements:

11. In the paper sacks experiment we proved that _____ air is pushed up by cooler air.

12.13. In the pyrex baby's-bottle and balloon experiment we proved that heated air (12) _____ and it made the rubber balloon (13) _____.

14. Much _____ is required to push a balloon filled with air into a tank of water.

15. An empty glass bottle with a stopper will _____ on water.

Turn paper over until collected.

Pupil's Name:_____ Date:_____

Men Fly -- The Airplane Now and in the Future

Section A: True - False Items: Instructions: In the proper spaces below, write a plus (+) if true, write a minus (-) if false.

( ) 1. Balloons are termed lighter-than-aircraft.

( ) 2. The first glider flight was made by Orville Wright in 1883.

( ) 3. Both Polar Regions were reached via air by Charles Lindbergh.

( ) 4. Captains Stevens and Anderson reached the stratosphere in a large balloon in 1935.

( ) 5. Drag is one of the forces that opposes lift.

( ) 6. Gravity is a force helpful to flying.

( ) 7. Thrust is a force that pulls an airplane through the air.

( ) 8. Barrage balloons played an important part in World War II.

( ) 9. Duraluminum is an alloy used a great deal in modern airplane construction.

( ) 10. Civil aeronautic authorities do not require pilots to file a flight-plan before making cross-country trips.

( ) 11. Celestial navigation is a great help to pilots on clear nights.

( ) 12. Pilots must have a clear understanding of latitude and longitude lines.

( ) 13. Air routes in the United States do not follow the Overland Trail.

( ) 14. Much first-class mail is carried by airplanes.

( ) 15. Air transportation is not safeguarded.

( ) 16. There are four main types of clouds.

( ) 17. Cumulus clouds are towering, rounded masses with flat bases.

( ) 18. The ailerons are located at the tail section of an airplane.

( ) 19. Stratosphere is the layer of space above the troposphere.

( ) 20. Flaps are used to help increase an airplane's speed.

Section B: Completion

Instructions: Complete the following statements.

1. The first non-stop flight across the Atlantic was made by _____ in 1927.
2. Helium is superior to _____ for use in balloons and dirigibles.
3. A variety of _____ conditions provide hazards for the aviator.
4. A motorless craft is called a _____ or a _____.
5. An aircraft having a fan-like propellor above the fuselage is called _____.

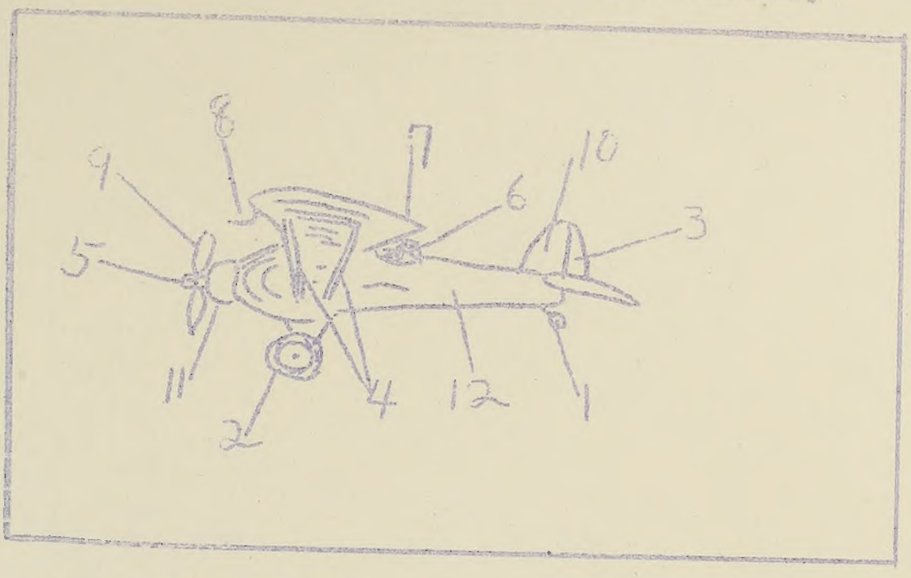
Section C: Matching

Instructions: Place in the blank at the left the number of the item which it identifies.

____canopy	1. Using stars and planets for direction.
____fuselage	2. P-39; P-40
____plywood	3. Affects horizontal direction
____bombers	4. Air disease
____fighter-planes	5. Acts same as a fin or keel.
____celestial navigation	6. Affects weather.
____contact flying	7. Main body of airplane.
____rudder	8. A sandwich of wood and glue.
____aileron	9. Area of space below stratosphere.
____stabilizer	10. Great circle lines.
____troposphere	11. Place where pilot sits.
____anoxia	12. B-17; B-29
	13. Affects vertical direction.
	14. Using ground objects for direction.

Section D: Identification

Instructions: Identify the listed items in the drawing and write the number in the space beside the name of object it identifies.



_____rudder
_____aileron
_____stabilizer
_____fuselage
_____landing gear
_____struts

_____canopy
_____propeller
_____cowling
_____tail wheel
_____pitch control
_____altimeter extension

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